THE MARINE REVIEW

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THE NAVAL WASTE

II*

THIS matter of care of equipment is one of the sorest spots on the naval body. About the most scornful thing that can be said of a merchant ship is that "she needs more doctoring than a battleship". How many vessels of the navy ever remotely approach their builders' trial performance? If she goes outside for a few hours her first stop is likely to be a navy yard. The cruise of the fleet to the Pacific, over which so much noise is made, was preceded by months of preparation, and will be followed by months of overhauling, while the press is overloaded with columns of rot about he "magnificent performance". Every day in the year old rusty tramps set out on this same voyage, without more than a few hours preparation, and complete it too, without a week's stop at every port of consequence along the way, and their crews think nothing at all of it. Go aboard a naval ship, almost any one will do, and listen to the generator engines pounding themselves to pieces. If you are fortunate enough to be allowed on board under way you will think the main engines are a battery of stamp mills. The steering engine never comes to rest but clatters away like a nail-making machine. Rear Admiral Bowles himself, formerly at the head of the bureau of construction and repair, now a builder, said in reply to a statement by a naval officer regarding "indifferent steering gears", that "there is quite a difference between indifferent steering gears and steering gears in indifferent condition". Steering gear, as well as other equipment, that will stand up year after year, in continual service with other people, is a failure as soon as the navy gets at it. Admiral Bowles spoke with knowledge.

*See introductory note in August issue.

Care of Naval Machinery.

This matter of the care of naval machinery has its humorous side too, or would have if it were not so serious. An officer of the Bureau of Steam Engineering, in a contribution to a recent number of the journal of an engineering society, gravely discusses the troubles the force has experienced with the lubrication of certain vital points of the propelling engines and their continual giving out in service after having successfully passed their builders' acceptance trials. He theorizes and speculates as to probable causes, but of course never touches the real root of the trouble, which is written plain over the whole face of the paper. If the engineer officer will forget a large part of his academy training and condescend to take advantage of the experience of those whose success depends upon results, or even from those subordinate to him in many instances, it would be to his exceeding great reward. Those of us who have had the responsibility of concerns who have to make good to maintain an existence, know how often theory and facts apparently clash, and how often we find that careful examination proves that we are trying to find facts to fit the theory instead of deducing our theory from palpable facts. The cordiality of the reception of suggestions does not, however, encourage the repetition of their offer. The officer in question talks of using on a four-hours run 540 gallons of oil on the main engines *as usual.* Think of it. There is nothing out of the way about the size or design of the engines either.

Again, he speaks of using about 2,000 gallons during a run of 4,500 miles, about *40 barrels.* It causes wonder as to whether the ships of the navy use the more coal or oil. And the solution of the problem so simple that only the navy would have such an experience.

In another number of the same journal another officer wades through 25 pages of abtruse calculations to demonstrate, in effect, that the engines of a certain ship could not possibly be run successfully, or in other words that the builders' acceptance trials were a dream, *although this same officer's signature is attached to a report on these same trials, at which he was present, and in which he states that "the machinery operated smoothly throughout and without difficulty."* But as soon as she passed to the control of the navy the trouble began and a reason must be found, hence the 25 pages of travail.

Still another officer contributes a series of papers on the care of naval machinery and which I read with ever increasing wonder at what must be his own estimate of the intelligence of those for whom he writes. If he is serious, he and those for whom his articles are apparently written should

be in a kindergarten or under restraint, anywhere but in the navy. It is inconceivable and outrageous that our navy is cared for and its design dependent upon such scant knowledge, and it goes far in accounting for some of the other things noted herein.

More Loss of Life in Peace Than War.

There has been more loss of life in our navy in peace than in war and not all unaccountable or accidental either. The most disastrous boiler explosion afloat in recent years was on the Bennington. You will look in vain in the bureau reports for more than a casual reference to it. Ruptures of tubes, pipes, "flare-backs", etc., with more or less serious consequences, are of common occurrence. For the number of ships in commission and the number of days and miles run, the United States Navy record, instead of being something of an example in at least some one respect, is, compared with the merchant service, a jest and a toy. A complete and utter disregard of cost or of public opinion pervades the whole service.

People have not forgotten, at least some of us haven't, how, a few years since, when a British fleet came to visit us, they threaded their way, without a pilot, up New York bay in thick weather, and before any one knew it they were in North river, while one of our own battleships could not go to sea in broad daylight, in clear, perfect weather, from the same harbor, without going aground. The navigating, or more properly speaking the handling, of our government vessels, brings a smile to the face of every coaster. It is besides a common complaint that they are the most persistent violators of the rules of navigation, and not a merchant master but will bear out this statement. I have time and again seen a naval vessel absolutely ignore the statutory passing signals imposed upon all alike and make no answer to the signals blown by a merchant steamer, and I have often wondered what the result of an inquiry following some disaster as a consequence of this violation would be.

Delay a Big Source of Expense.

Another fruitful source of expense is the eternal delay which seems to attend every move. Take a look through some of the bureau reports, which it has been remarked are valuable chiefly for what they don't tell. Take the last report of the Bureau of Yards and Docks. On almost every page you will find evidence of bureau methods, one of which is, apparently, to use the contractor, where there is one, for a shield. Almost the first item we come to refers to the new dry dock for the New York yard, authorized June 7, 1900. On Feb. 7, 1905, the bureau had got far enough to sign a contract, and now the contractor has thrown up the job. By-the-way, dry dock contractors to the government seem to find progress even more difficult than others, as the original contractors for both the League Island and Mare Island docks did the same thing.

The dock at Charleston, S. C., was authorized March, 1901, and, the Report says, "is all finished with the exception of the caisson* which is building at the Norfolk navy yard." The dock was built inland and a channel had to be dredged to it, and now, after seven years, a contract has been let for this dredging, "but the contractor has been slow to start work." Regarding the caisson, as well as that for the Norfolk dock authorized in 1900, it appears that its probable date of completion is Oct., 1907, "but depends on delivery of material now overdue." So, here are two docks, one six and the other seven years old, still waiting for the delivery of material for the gates, probably ordered about a month before the report was filed.

We will select a few items as we pass along; to enumerate all would be to practically rewrite the report, but a couple of pages further on we read that a wire-rope mill for the Boston yard, for which appropriation was made in March, 1904, and "urgently needed", has not been even started because of "no decision as to class of building or its location". This is a gem.

At Charleston, a power-house for which money was appropriated March, 1903, was contracted for in September last, four and a half years later.

At Key West, a store-house, authorized March, 1901, has got as far as taking soundings and making plans, but officers' quarters provided for over 5 years later (1906) have been completed. Also a coaling plant authorized March, 1903, has reached the same stage as the storehouse. At this yard also a building for the bureau of construction and repair, authorized in June 1900, "has not yet been begun"; no reasons given. The same bureau asks for a foundry at this yard although a new one has just been finished for the bureau of steam engineering and seldom has anything to do.

At League island, a dock authorized in 1898 is not yet finished. In connection with this dock, the writer happens to know that the contractor who built the engines for the pumping plant had his contract completed and waiting for two years for the bureau to arrange to get water into the plant before he could make his contract trials. The work necessary before this could be done was not contracted for until about 4 years after the machinery contract was placed and then the contractor is given 4 months in which to do it and is handed a criticism for not moving faster.

New Orleans coal storage plant, authorized March, 1901, work begun 5½ years later (Nov., 1906), "progress has been slow."

Norfolk yard, dry dock authorized June, 1900. Six and a half years later (Nov., 1906), the contract for the pumping machinery was let. Dock said to be 76 per cent completed.

Portsmouth yard, a coal storage plant for which $10,000 was appropriated March, 1901, has progressed so far that the bureau has obligated $800.

These are only a few random examples, and when we come to the estimates we find almost every item marked up "important", "urgently needed", "should be done at once," etc. Five or six years later the same comments may be made of them. Amongst the "most necessary" are coaling plants and the secretary himself makes a piteous appeal for these, backing up his bureau chief. Judging from the speed with which these already authorized are approaching completion, the millenium will be upon us and the need of warships and coaling stations have passed before they are built, so why waste the money? Or at the least they will be "obsolete."

Some Gems in the Estimates.

There are a few gems in the estimates also. The bureau of yards and docks asks for $125,000 for a hydraulic dredge, saying that in the removal of a job of 4,000,000 yards which the bureau has on hand, its cost can be saved. The writer knows something about hydraulic dredges, he has built a few, and he also has bid on others under government specifications, and knows about how much the bureau will get for its $125,000 and how much it will save on the 4,000,000 yards. It is a question of bookkeeping, and it is well known that there is nothing so misleading as facts except figures. Any man can make a

*Gate.

showing under the government's method of charging costs that would start all the contractors in the country into the dredging business.

At New York "only $231,000 is required *to complete* the yard power plant". Last year the power plant and electric plant had $360,000 to spend, of which $140,000 was for the central power plant (which is *not* a central power plant at all) and which was not used. If we take the total for the "electric plant" and "power plant" last year and add the estimate for this year, without going any further back, we have $631,000 for two years on a power plant that any industrial concern would get three or four times the work out of for half the money.

At Norfolk $200,000 is asked to widen the existing 600 ft. channel in front of the yard because turning a battleship or a cruiser "is a difficult and hazardous operation". Seeing that the longest ship in the navy is not over 450 ft. long it will not strike any sailor as being either. I expressly differentiate between naval men and sailors. Let the naval officials go up to the great lakes and see 600 ft. ships maneuvered in crowded harbors and narrow channels without 25 ft. to spare and often without even a tug. These fresh water skippers would put to the blush any man I have ever seen handle a naval ship, for all that the latter are invariably twin screw and high powered, and ought to be as handy as a tug.

At the same yard the new dry dock, building since 1900, it is now discovered cannot be used "efficiently" until a $95,000, 40-ton traveling crane is provided, with its track. It is surely a "hand-tooled" crane and nickel plated track. The writer recently made a bid on a 60-ton floating crane, including pontoon, for a great deal less money and was not lowest bidder at that.

The Guantanamo Dry Dock.

At Guantanamo, Cuba, $2,250,000 is asked for a dry dock. If the reader has sufficient curiosity to go back over the report for 1906 he will find that the estimated cost of "a dock of the largest size with 37 ft. of water over the sill", is $1,750,000, "but on account of the increase in labor and material it is advisable to increase it to $1,850,000". But the report for 1907 boosts this again to $2,250,000 and doesn't even go to the trouble of giving a reason, but, in effect, says to hurry up with it.

Examination of the report, which begs for this dock most piteously, will disclose that this does not mean a dry-dock in the ordinary sense of the term. It is only a beginning. When it is about so far along it will be found that it is inland, like the Charleston dock, or that it will need pumping machinery like Norfolk, or bilge and keel blocks, or a caisson, or traveling cranes, and we will be asked for more for "urgent needs". I know a shipbuilding plant, one of the very best in the United States, that was built complete, including a 600-ft. dock, the latter one of the best in this country or anywhere, *for less than the amount asked for this dock as a beginning,* and the plant referred to employs over 2,000 men and last year turned out close to 50,000 tons of steam tonnage, and it was projected, built and finished, dock and all, *in less than three years.*

At New Orleans we have one of the largest floating docks in the world, placed there 6 years ago, and costing over $1,000,000. The report of 1906 shows that during that year this dock, together with the shore equipment, did business with 12 barges, lighters, dredges, schooners, etc., and nothing else, and during 1907 it docked 2 dredges, two foreign vessels and one collier. For the same period (1907) the bureau of supplies and accounts shows an expenditure for account of this station of, in round figures, $364,000, without adding anything for interest or depreciation as is perfectly proper and which would bring the total up to over $500,000; all for the performance of perhaps $10,000 worth of work. Yet the wail for more docks never ceases.

Over $150,000 to Care for Four Small Vessels.

At Guantanamo, again, the report shows that during the year the bureau of construction and repair employed an average of 52 men, exclusive of officers and foremen, and that the only work done was minor repairs to one tug, hauling out another and a coal float, and completing a little wooden punt of a lighter. This station cost us for maintenance alone, to handle this stupendous business, over $150,000.

The bureau of construction and repair makes heart-rending appeals to the country to provide quarters in the yards for its representatives so they won't have to take so much time going to and from work and "so that they can give more time to the yard". It appears that in one case (Charleston, S. C.) the unfortunate man has to take an hour and a half each day for this. So we pay these people for the time they spend enroute also. How does the average citizen like that? However, it looks a good deal more like an effort to provide free quarters than to improve the service, and the writer gives it as his deliberate opinion that most, if not all, of those constructors with whom he has come in contact really need more exercise, and if they will only put in the full hours paid for we will forego the improvement to the service and let them continue to live outside the yard.

Appeals are made for additional buildings at all yards, all in the utmost haste, yet the records show that once the appropriation is made the necessity seems to disappear.

A Most Misleading Statement.

Before leaving the report let us pay our respects to the statement that "the impression is general that navy yards are extravagantly operated, while as a matter of fact, the expenditures for operation and upkeep are much less than the best industrial and railroad corporations." Following this statement are tables showing that "Maintenance, Repairs and Preservation" run as low as 1.10 per cent *of the valuation,* "while industrial concerns spend an average of 6 per cent of valuation, disregarding depreciation, for the operation of their plants".

A more misleading statement it would be difficult to find. It oversteps the line of departure from the truth. The figures quoted by the bureau do not include either the salaries of officers nor or the "civil establishment", which covers clerks, messengers, electricians, draftsmen, foremen. tug-masters, stenographers, etc. Where is the industrial concern or railroad that excludes such items from operation? That statement was not made in ignorance either. The basis of valuation is absolutely misleading because it is in no sense any indication whatever of the relative cost of operation, has absolutely nothing whatever to do with it, and is not used, in industrial plants at all events. The volume of business done is the basis of operative cost in every live concern. In a railroad the cost of operation covers expense of every sort and description because a railroad produces nothing, it exists solely to perform a service, while in the navy yard even the cost of work done in and by the yard for the ships of the navy is charged against those ships. As to valuation, no industrial concern, or railroad either, could exist if its property investment bore, even remotely, the relation to output of that of the naval establishment. We do not ex-

pect the navy to produce for its investments as an industrial concern; they are largely anticipatory and preparative, but if the department invites comparison it should set forth its own side truthfully. The report itself is authority for the statements herein, and the writer does say and every one at all familiar with the subject knows, that the general impression is absolutely correct, only that those who furnish the money do not know but a fraction of the truth.

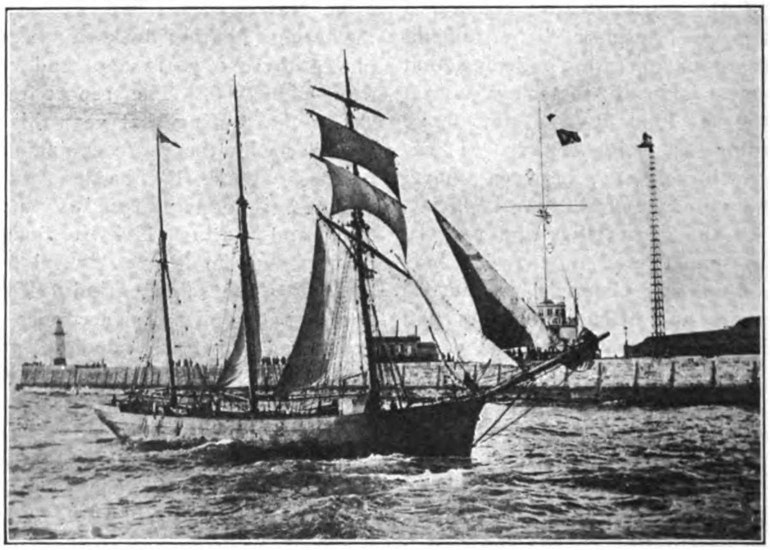
(To be continued.)

AUXILIARY MOTOR SHIPS

The Sailing Ship Not to Become Extinct Yet

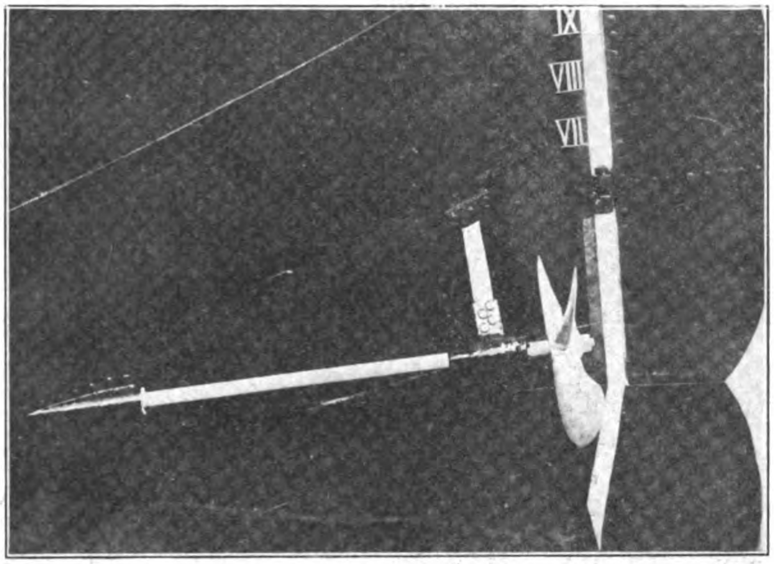
THE marine motor is slowly but surely coming to the front amongst a large section of British ship owners as an auxiliary power for sailing ships and small coasting vessels. It is the common complaint that the wind-jammer does not pay and must give way to the steamer even in those trades in which for many a long year she has reigned supreme. The fact is being demonstrated by daily experience that a vessel containing within itself the means of propulsion is capable of doing more work than the sailing vessel absolutely dependent for progress on the wind. But it has got to earn interest on a greater capital expenditure, and it can only do that by carrying more and turning round quickly. Obviously, therefore, there must be coasting trades from which economic sizes of steamers would be barred. As a general rule, however, it is true that the coasting steamer must displace the sailing coaster, provided—and this is where the whole question turns—the owner of the sailing coaster cannot equalize the conditions of competition from the standpoint of his own invested capital. In other words, whether the sailing boat is to stay in the business or to go out of it, is in his own hands to decide. The coasting owner, like the general ship owner, must shift for himself if he means to stay in the business.

SCHOONER EILIAN.



BARKENTINE ALEMBIC.

The illustrations we give is evidence that he means to shift for himself. We give two of several vessels that have been fitted with auxiliary motor power, and already they have a record of excellent work in wintry weather to their credit. The coaster with an auxiliary motor is a far likelier alternative to the coasting steamer than appears on the surface. The trade which she has to do exists, and all the port facilities for handling it are ready. The sailing vessel has been developed to carry on this particular trade, and the port facilities have kept pace with her progress. To accommodate the steamer, considerable change would be necessary ashore, and to make room for her in the business the sailing boat would be broken up. All the capital represented by boats and facilities would have to be written off. By fitting auxiliary motors to existing sailing coasters all that waste of capital is avoided. The only effect is a comparatively slight increase of the capital fixed in the boat, which raises the economic efficiency of the invested capital to such a height, however, that the margin of profit shown in a steamer economy seems ridiculously narrow. To describe one of the two vessels we illustrate, namely, the Eilian, which is a typical schooner engaged in the North Wales coasting trade. She is 102 ft. long by 22 ft. beam, and on a draught of 9 ft. 6 in. carries 230 tons deadweight. She is built of steel to Lloyds A1 class, and at the load displacement has a speed of 5½ knots under motor power alone. And this auxiliary power does not necessitate the employment of an extra hand, for the engine is run by the captain. The fuel for the motor is stored in the engine room. While neither the owner of the Eilian nor Messrs. Perman & Co., London, the British and colonial agents of the makers of the Kromhout motors, are inclined to say much about the economy of the vessel, it is the fact that the working of the ship is highly satisfactory, and Mr. Perman has some very convincing figures on the subject which prospective buyers of marine motors would be privileged to see. The interesting feature is of course the Eilian's auxiliary motor. This is a Kromhout paraffine engine of 56 horsepower at 285 revolutions per minute. Since her completion in November, last year, the Eilian has done excellent service, traveling no fewer than 1,920 miles in 387 hours on ten voyages in whatever kind of channel weather came to her. Of course so far as the expense of working these boats is concerned, it has to be borne in mind that they are auxiliary



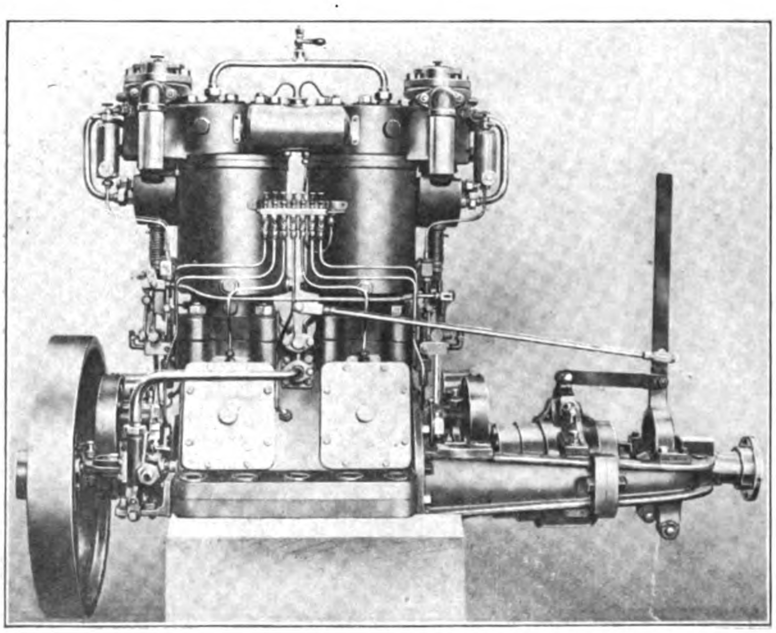
SHOWING PROPELLER OF BARKENTINE ALEMBIC.

motor coasters. They are not motor coasters to be run anyhow, and all the time under power. On the contrary, order to obtain the full economy the power ought only to be used where the canvas is sufficiently ineffective as to delay the vessel or in saving towage in or out of port. The economy of a vessel designed to depend mainly on her motor is necessarily a totally different affair.

Auxiliary Motor Barques.

It is also interesting to note that amongst British ship owners there is some movement towards equipping the larger kind of sailing vessels with auxiliary motive power. The sailing ship is to have another lease of life, and it must be remembered that there are hundreds of fine iron and steel ships afloat—vessels which in earlier days paid good dividends. What is to become of them? Admittedly they are unprofitable to work in the present day against the modern steamship. The most advanced pioneer of the auxiliary motor movement as applied to sailing vessels among British owners is the Clyde-built ship Modwena, but though her tonnage is only 500, and therefore a good bid short of the register of the average windjammer of trade, she represents a sufficient advance on the immediately preceding record of dimensions to justify the hope that auxiliary motor power may ultimately save the sailing ship from extinction. The notable feature of the design is that she is an ocean-going sailing vessel primarily, her crew is practically that of a ship, and the source of her auxiliary power takes up very little room. The Gardner paraffine engine installed on the Modwena is of a special six-cylinder type, which was designed for some Russian submarine boats. The diameter of the cylinders is 11 in. by 10-in. stroke, and on the test bench the motor developed 200 horsepower at 450 revolutions per minute. The Gaines reversible and feathering propeller is two-bladed, and enables the propeller to be masked by the stern post so that there is no drag when sailing. The diameter of the propeller is 54 in. This is the largest reversible and feathering propeller so far installed. The fuel is paraffine, and the speed of the boat on her auxiliary power is 9½ knots. Judged by the figures above given the installation is almost ideally economic. No doubt 200 horsepower is beyond the power which many trading vessels of the same dimensions could carry with a certainty of earning money. The Modwena, too, is much bigger than the average coaster to whose case marine motor makers are diligently applying themselves just now. Still, through the figures relating to the Modwena, the coasting owner may learn a great deal. The fact that a Gardner engine of this type and power costs probably $10,000 may possibly stall off many inquiries right away. It is, however, the bearing of her success on the problem of the ocean-going auxiliary sailing ship that makes the Modwena the interesting vessel she is. In her engine installation two new problems had to be solved, and it is in respect of these that justifies the hope there is regarding the future of the auxiliary motor power for ocean-going sailing vessels. One was how to cool the exhaust, and the other how to provide for the fresh water drip to the snifter air valves. Curiously enough the makers found a solution of both problems in one. The exhaust is led through two pipes fore and aft of the motor into two cooling cylinders, 15 in. in diameter and 3 ft. high. Seacocks below the water line admit sea water to these cylinders, most of which immediately evaporates on contact with the exhaust. The mixture of the exhaust gases and steam then rises through a series of baffle plates in the upper part of the cylinders, all the salt being deposited on the baffles, which are removable through gas-tight doors. Most of the exhaust, thoroughly cooled, passes out through the usual vent pipe, while the heavier steam passes into a condensing cylinder set between the evaporators, whence it is pumped up as fresh water to the water drips.

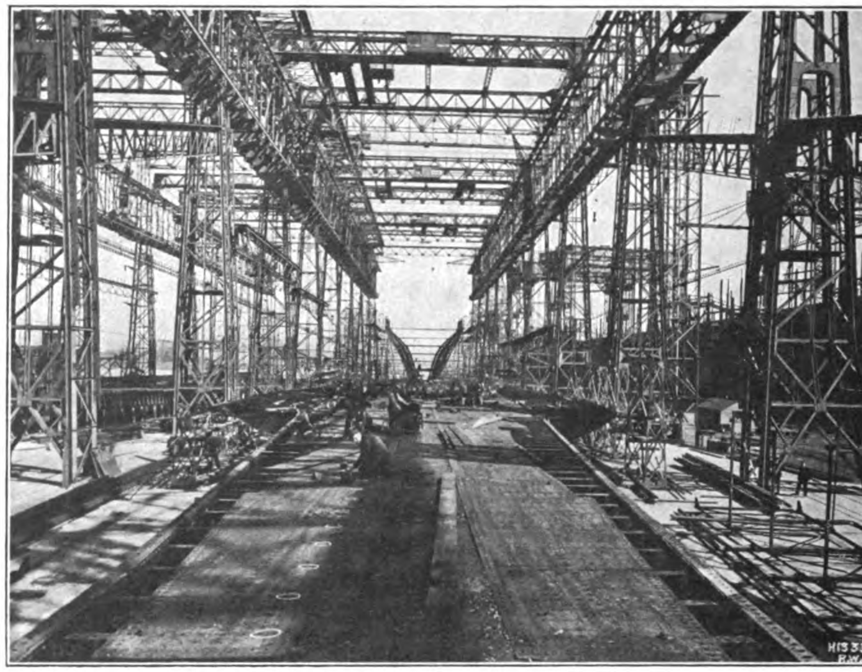
While these are important advances, it is not to be assumed hastily that there



56 H. P. KROMHOUT OIL ENGINE.

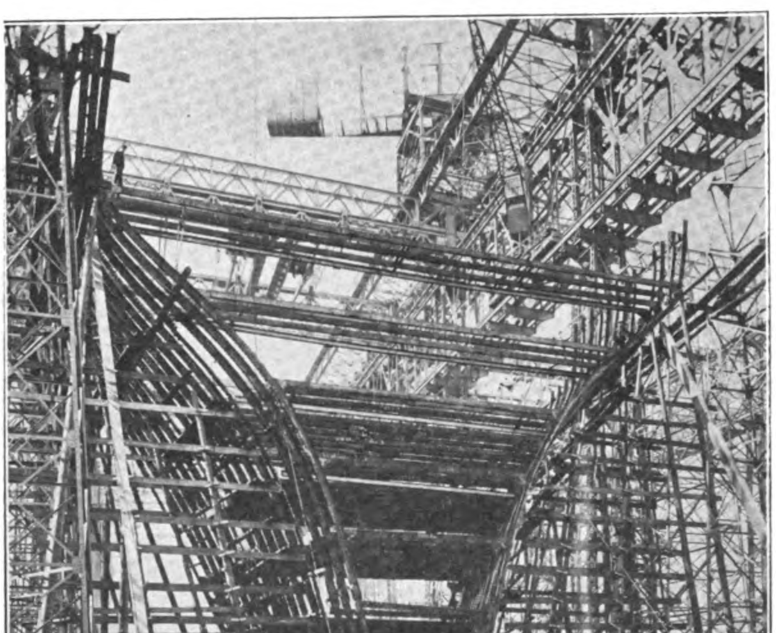
is no barrier of any account to the employment on ocean-going sailing vessels of even larger auxiliary powers. It is not known yet what it costs to run the Modwena, but it seems to be established that what the steam engine gains in economy as the power is increased, the oil engine does not. There is nothing to be gained, therefore, by going beyond a certain limit, and in the absence of an inducement of that kind makers are naturally disinclined to try to go beyond it. Inside the limit, however, the oil engine maker has it all his own way, and he is not absolutely hopeless of sooner or later gaining economy by going to larger powers.

NEW WHITE STAR LINERS OLYMPIC AND TITANIC.



S. S. OLYMPIC. VIEW OF TANK TOP LOOKING AFT SHOWING WING TANK FLOORS. TAKEN JULY 30, 1909.

In the evolution of the modern liner there are well-defined stages of construction besides the five familiar stages of the laying of the keel, framing, plating, launching and completion. These are the terms used to denote the main stages of construction, but in the larger and more complicated structures of the present day there are many intermediate stages that have an interest of their own, and afford an indication of the progress of the work. This, of course, is especially the case in such gigantic vessels as the new White Star liners Olympic and Titanic, now under construction at Belfast, and the reports that have already appeared describing one of these intermediate stages, viz., the construction of the cellular double bottom, have dealt with a number of interesting points regarding the keel, center plate (or inner vertical keel), floors and other parts forming this portion of the ship, special attention having been directed to the large amount of hydraulic riveting and the appliances for carrying on this work.



S. S. OLYMPIC. VIEW FROM COFFERDAM SHOWING FRAMES. TAKEN JULY 30, 1909.

The double bottom (which in these vessels is more extensive than usual, being carried round the bilge), as is well known, serves several purposes. It provides space for water ballast, which, being so far down in the ship, has an important influence on the stability, which can thereby be regulated as desired under certain conditions. Then, while contributing greatly to the strength of the whole structure, it forms an important element of safety in the event of the vessel grounding at any time, the ship, in fact, having, as the term implies, a double bottom.

It will be seen from the accompanying illustrations that the tank top plating is now well advanced, and that the next important stage is being proceeded with,

viz., the main framing of the vessel. These frames form the ribs of the ship, and it will be observed that a number of the Olympic's have already been set up near the after end. It is expected that the stern frame will be placed in position shortly, when the progress of construction will be even more apparent than it is now.

Sixty Years of Merchant Ship Building on the North-East Coast

AT the joint summer meeting at Glasgow of the Institution of Engineers and Shipbuilders in Scotland and the North-East Coast Institution of Engineers and Shipbuilders, the following paper on "Sixty Years of Merchant Shipbuilding on the North-East Coast," by Dr. G. B. Hunter and Mr. E. W. DeRusett, was read:—

By the North-East Coast is meant the district which streaches from Blyth to Whitby, and includes the Tyne, Wear and Tees, and the Hartlepools—a locality rich in minerals, such as iron-ore, together with limestone and excellent fire clays; while an abundance of coal lies close at hand for the conversion of the crude materials into pig iron, and the plates, bars, sheets and castings required by shipbuilders and engineers. For a very long period this coast has been famous for its shipbuilding. As early as 1642 a committee of the house of commons designated Newcastle as the "nursery of shipbuilding"; and Defoe, writing of the Tyne in 1727, states that "they build ships here to perfection—as to strength and firmness, and to bear the sea."

Wood Shipbuilding.

Wood shipbuilding continued to be one of the great industries of the North-East Coast down to 50 years ago. In 1860 only about 30 per cent of the new tonnage built in the United Kingdom was built of iron. East Indiamen of the largest dimensions, Blackwall and other liners, were built by the old firms of T. and W. Smith, North Shields, who began shipbuilding in 1782, and J. and P. Laing, who began in 1793, and William Pile at Sunderland, and others. At the beginning of the nineteenth century the largest ships built at Sunderland were under 100 ft. long, the breadth being nearly one-third of the length. Taking the Alnwick Castle, built in Sunderland in 1857, as a later example, her dimensions were 195 ft. by 35.3 ft. by 22.5 ft., and register tonnage 1,087. Among the most noted wooden sailing vessels built on this coast were the Blenheim and Marlborough of 1,387 and 1,392 tons register respectively, each being 175 ft. long by 42 ft. beam. They were built under government survey by Messrs. T. and W. Smith, of North Shields, in 1846-1848, and so famous were they that in the Exhibition year of 1851 they were presented with silk ensigns and house flags as being the finest merchant ships afloat. The Blenheim was employed as a regular passenger and transport liner to India, via the Cape, until 1867. These fine old ships had no pretentions to speed. An average good day's sailing was between 220 and 240 knots, while on very special occasions 280 knots might be got out of them. So late as 1873 steamships 260 ft. long, 1,500 tons gross register, and 2,250 tons deadweight, were spoken of with awe as "the big ship"—and the price of plain cargo steamers of that size was about £14 per ton deadweight.

Hours and Pay.

The old Sunderland wood shipwrights were among the most capable and hard working in the world. Their working hours were long, and their pay as low as 3s. 6d. per day, for which they worked 12 hours—Saturdays included—less meal times, and they worked twice as hard as the men do now. They were not noted perhaps for unnecessary exactness in their work, but in respect of both quality and quantity they took the same pride and pleasure in their day's work as many ship workers of the present day do in football and racing and coursing. Great were the discussions among them in the middle of the last century, and among their masters too, as to whether iron ships could float, and whether they could be relied upon not to tear in pieces through the rivet holes.

Iron Ships.

It is of interest to note that, while in Scotland and on the Tyne the first builders of iron ships appear to have been engineers and boilermakers, some of the first builders of iron ships on the North-East Coast were wood shipbuilders. The latter were not so much accustomed to exact work as the former and from 40 to 50 years ago Scotland had acquired a higher reputation for good work than some districts, at least, of the North-East Coast. Of recent years, while many Scottish builders maintain their high reputation, it is well known that in no part of the world is better work done in shipbuilding and engineering of all classes than on the North-East Coast. In the sixties of last century very fine sailing ships were built, of 700 tons and above, with frames, diagonals, two strakes of shell, beams and stringer plates all of iron, and with wood planking and yellow metal sheathing. In connection with these "composite ships" the first iron sheds over building slips in this district were used.

The John Garrow.

Although long noted for the building of wooden sailing ships, with now and then a wooden steamship, the use of iron as the chief material in their construction did not commence on the North-East Coast until the year 1840. It is said to have been hastened by the arrival at North Shields in March, 1840, of the iron sailing ship John Garrow, of 685 tons register, built in Aberdeen in the same year. Her advent caused considerable excitement, and a shipbuilding firm at Walker-on-Tyne (Messrs. Coutts & Co.) with John H. Coults, of Aberdeen, as head, and the late Charles Mitchell as draughtsman, almost immediately commenced building iron ships; their first production being the steamer Prince Albert, built for passenger service on the Thames. She was launched on Sept. 23, 1842, at Walker-on-Tyne, on the site afterwards occupied by Messrs. Wigham Richardson and Co., 1860, and Charles Mitchell went with her—or with the Q. E. D.—one or two voyages as engineer.

The Great Britain.

Another incident which encouraged the use of iron in shipbuilding was the remarkable way in which the screw steamer Great Britain stood the strains during the winter months when she was on shore in Dundrum Bay, where she was visited by Mr. James Laing, who decided to commence iron shipbuilding in 1852. He launched his first iron vessel, the Amity, in 1853, but continued

building wooden vessels till 1865. C. M. Palmer commenced shipbuilding at Jarrow about the year 1851. C. Mitchell commenced the business at Walker in 1852, which was afterwards—about thirty years later—amalgamated with that of Messrs. Sir W. G. Armstrong & Co.; and Andrew Leslie, another Aberdonian, about the year 1853, commenced the shipyard at Hebburn-on-Tyne, now owned by Messrs. R. and W. Hawthorn, Leslie & Co.

The John Bowes.

During the eight or ten years following 1842 but little progress appears to have been made in iron shipbuilding on the North-East Coast. The vessels then mostly in demand were colliers, and coal-carrying interests were vested in the fleet of wooden vessels already employed in the trade. About the year 1850 the carriage of coal to the London market by rail so seriously affected the sea-borne trade by its competition that it called for the introduction of an improved type of collier ship which could be worked more economically and deliver its cargo more expeditiously and in better condition. The enterprising firm of Palmer Bros. & Co., of Jarrow, met the need in 1852 by building the John Bowes. She is a vessel of 167 ft. long over all; her register dimensions being 151.9 ft. by 26.3 ft. by 15.2 ft.; gross tonnage 459; her engines, of 70 H. P., consist of two cylinders, and she carried about 540 tons. There was a large hatchway 60 ft. long to minimize trimming. The water-ballast tanks were pumped out by the main engines.

£18 10s Per Ton.

It is on record, to arouse the envy of future generations of shipbuilders, that her price was about £10,000, or £18 10s per ton deadweight. These were the good old days! Need we say it was prophesied that she would prove a pecuniary failure? But happily the prophets were disappointed. She made more than four voyages to one of the old sailing colliers; and a new era in shipbuilding was inaugurated, and an impetus given to local iron shipbuilding, which before long made the North-East Coast famous for building cargo steamships. The John Bowes is still running, but under the name of the Carolina. She has recently discharged a cargo of oats in the Tyne, and it is worthy of record that but few of the plates or frames have been renewed. The latter are about 15 in. apart, and are now—as might be expected—somewhat thin at their edges. She is said to be as tight and dry as ever, with a reputation for being a good sea boat.

Ballasting.

It is of interest to read the remarks made by C. M. Palmer when writing on the construction of iron ships in 1864:—"One of the great difficulties we had to encounter in perfecting these vessels was in the ballasting. To dispense with the necessity of shipping shingle or chalk as ballast, many costly experiments were tried, and at length, by a system of double bottom, the construction of which adds to the strength of the ships, the ballasting of the vessels with water was brought to a highly satisfactory result." The importance of this improvement will be best realized by anyone who contemplates the amount of labor expended in the transportation and formation of those miniature mountain ranges of shingle, called ballast heaps, which decorate the banks of the Tyne. It should be noticed that as early as 1844 a small sailing vessel, the Q. E. D., of 271 tons, was fitted to carry water ballast, and was equipped with auxiliary steam power by R. and W. Hawthorn, and employed in the coal trade. The engines were placed aft and the screw propeller was made to disconnect so that the vessel could be navigated under sail only.

Tanks.

To John McIntyre—Messrs. Palmers' first manager—belongs the credit of improving the details of design and construction of water ballast tanks, and a certain type of tank was identified with his name. In this type the floors were of the normal depth, and on them were built continuous keelsons about 18 in. deep, to which the tank top was riveted. The steamship Black Swan, built by Thomas and William Smith on the Tyne, in 1864, was constructed with water ballast tank tops of elm, which is said to have proved as tight as iron, and it is stated of this ship, "She is as good for all purposes today as when she was built." In those early days less care was taken in constructing, making tight, and testing water ballast tanks than at present. They were sometimes tested without closing the manhole doors on the tank top, with the result that cargoes were damaged and water ballast tanks fell temporarily into disrepute.

Cellular Double Bottoms.

In 1876 the present method of constructing ships with cellular double bottoms, with transverse continuous frames of the ordinary spacing, intercostal keelsons connected to the shell and tank top and deep floors, was introduced at Sunderland in the steamship Fenton, built by S. P. Austin & Hunter. The Board of Trade at first included in the gross tonnage the part of the ballast tank which was above the normal height of the ordinary floors, a space of about 18 in. in depth, but the late William Denny contested this practice with the Board of Trade, which resulted in the double bottom and other permanent spaces used for water ballast and not available for cargo being excluded from the register tonnage.

In 1854, when the commissariat department of our army in the Crimea had broken down, it was found that screw colliers were admirably suitable for the work of rapid carriage of supplies and despatches, the government stating that these vessels had proved to be more useful than any other class it had employed. It is of interest to note, on the authority of B. Martell, that the general adoption of iron on the Wear for shipbuilding dates from about 1863, and that by 1880 this material had almost entirely taken the place of wood in that district. On the Clyde and Mersey as well as on the Tyne iron shipbuilding was originally adopted at an earlier date.

War Vessels.

To the north-east coast, also, belongs the prestige of having constructed the first iron vessel for war purposes. She was built by the Palmers' Co. in 1856, and was named Terror. She was built with commendable patriotic energy in about three months. Her displacement was 2,000 tons; she mounted 16 300-lb. guns and was propelled by engines of 200 H. P. The hull was built of iron in the ordinary way, but with sides sloping to an angle of 25 degrees, which were protected from shot by iron armor plates 4 in. thick, tongued and grooved together, and backed by 6-in. teak, all bolted to the main structure. Prior to this, wooden war vessels protected by hammered iron plates were used, but Messrs. Palfer & Co. made the armor of rolled iron plates, which proved on testing to have more shot-resisting power than hammered. They were known as "Palmer's rolled plates" and this system of manufacture has now been generally adopted.

Suez and Steam.

When the Suez canal was opened in 1869 great impetus was given to the building of steam propelled vessels, which soon cleared the seas of the majestic and beautiful sailing composite vessels for which this and other districts had become famous; some of which made very fast passages on the annual race homeward from China with

the new season teas, their passages being watched with great interest and excitement. The opening of the canal, together with the close of the Franco-German war, probably accounts for the leap which took place in the output of this district about 1872, the tonnage rising for the five years ending 1868 from 17 per cent of the total output to 30.4 per cent. Up to this time iron sailing ships had been largely built.

The cargo steamers built on this coast became noted for their economical steaming and large carrying qualities, the old fine-lined yacht-like models giving place to vessels built with much fuller lines. In the discussion of a paper read by J. Hamilton Jr., at the Institution of Naval Architects in 1883, B. Martell said that the north-east coast models "are admitted to be more profitable for general cargo carrying purposes than the form of vessels originally built on that river" (the Clyde), and J. Inglis said the Clyde builders were "so much engaged in building fast vessels for the carriage of mails and passengers that they were content to leave the cargo-carrying ship to the east coast." Since 1883, however, the position has completely changed, and the north-east coast has turned its attention more to fast and intermediate steamers of the highest class, and Clyde builders have largely taken up the building of cargo steamers. The earliest iron shipbuilders on the Tyne and Wear, and most of their workmen came from Scotland, and from the beginning until the present time there has been much interchange of talent and energy between this district and Scotland.

Sixty-Fourthers.

On the north-east coast were first built, but at Cardiff and in the south-west were largely owned, the class of cargo "tramp" steamers, known as sixty-fourthers, because the ownership was divided into sixty-fourths; and numerous small capitalists, as well as large, invested their money in ships, sometimes to their advantage, but always to the advantage of the "managing owners." The first, or one of the first of these, was ordered with great hesitation by George Pyman, of Messrs. Pile, Spence & Co., of West Hartlepool, and was said to have carried 700 tons, cost the owners £14,000, and cleared anything up to 60 per cent per annum profit.

Well-Deckers.

Vessels of a peculiarly successful type known as well-deckers had their origin on the north-east coast, for they were first built in the Hartlepools in 1865. This type of vessel was at first looked upon with some distrust, and serious misgivings were expressed as to its safety and sea-going qualities; but it proved to be eminently satisfactory, even when the well was filled with water. Mr. Martel, when speaking at the Institution of Naval Architects in 1892, remarked that the well-deck type of vessel had proved itself by reliable statistics to have exceptional immunity from the loss as compared with others; and Edward Withy, of Hartlepool, when speaking in 1882 before the Institution of Naval Architects, said: "Out of 101 vessels which we have built and sent to sea within the last 13 years, three-fourths were well-deckers; some of them had long poops and some quarter decks, but all had wells, and of this number there was only one suspicious case of loss."

The origin of the well-deck steamer was the need of additional cargo space at the after end, to compensate for the space occupied by the engine-room and shaft tunnel, and enable full cargoes to be carried without loading the vessel "by the head." Short raised quarter-decks were designed, and afterwards long raised quarter-decks, together with long bridge houses and topgallant forecastles with deep wells between the bridge front and forecastles. Later, the original intention was forgotten, and vessels began to be built with the bridge houses joined to the forecastle, and long raised quarter-decks aft; so that the space for cargo was much greater forward than aft. Finally, one "improvement" after another has led back to the old plan—flush decked, with full poop, bridge and forecastle!

Self-Trimming.

Self-trimming colliers were introduced about the year 1877 by Mr. Kerr, of Sunderland, and afterwards improved by John Price, at Jarrow.

It was not until about the year 1885 that the use of mild steel began rapidly to displace iron in the construction of ships. A year or two later triple-expansion marine engines, with boilers of 150 lb. working pressure and upwards, began to be generally used.

Turret Type.

Amongst other types of vessels which owe their origin to the builders on this coast may be mentioned the well-known "turret" vessels, introduced by Messrs. Doxford in 1892, when they built the Turret of 1,970 tons gross. Since then 179 turret vessels have been built, measuring in all 685,000 tons. The turret type of steamer was designed to have a small register tonnage in proportion to the deadweight, also to be a self-trimmer and a large deadweight carrier. These objects have been accomplished by the peculiar transverse form of the vessel above the water, which is of an ogee section, the upper or turret deck being much narrower than the lower or harbor deck. It is also claimed that the structural weight is relatively small without diminution of necessary strength. These vessels have wide hatchways which, with the upper part of the cross section cut away, makes them practically self-trimmers. Then the draught assigned being favorable, and the net register tonnage being reduced by the peculiar form, the proportion of deadweight to net tonnage comes out relatively large. In some of these designs provision is made for dispensing with pillars in the hold, either entirely or partially.

Trunk Steamers.

Messrs. Ropner & Sons followed with their patent "trunk" steamer, building the Trunkby in 1896, and since then 43 others, the total tonnage reaching 165,500. In Messrs. Ropner's trunk steamer the side above the water is rounded inwards in the same manner as in Messrs. Doxford's turret, but the upper part of the side is vertical instead of being curved. The trunk, as in the instance of the turret, is of the same height as the poop and forecastle, to which it is united, and they are, as a rule, like the turret steamers, without sheer.

Messrs. W. Gray & Co. built their first McGlashan's patent "side tank" steamer, the Mancunia, in 1898. This vessel proving successful, was followed by 10 others, the total gross tonnage having now reached 40,100 tons. In Messrs. Gray's steamer the peculiarity is that she has double sides fitted for water ballast. These extend from the double bottom to the underside of the upper or main deck, and longitudinally from half to three-quarters the length of the ship. As in the Dixon-Harroway "cantilever" design, this provides for augmented water ballast space which is not included in the tonnage, and the center of gravity of the ballast being raised makes an easy ship when in ballast trim. In these vessels, the proportion of deadweight to register tonnage is favorable to the ship owner as it is in the turret, trunk and cantilever types.

Sir Raylton Dixon & Co. began building vessels on their so-called cantilever framed principle in 1904, with the Hedwig Heidman, of 2,200 tons. On their patents 22 vessels have been

constructed, measuring 83,490 gross, including erections.

In Messrs. Dixon's cantilever steamer the peculiarity is that triangular water ballast tanks are built at the sides of the vessel, the top forming part of the upper deck. The inner sides of the tanks being sloped, and the main frames of the vessel being turned inwards to support them, pillars are dispensed with, the combined tank and framing supporting the deck from the ship's sides.

Longitudinal Framing.

At present a good deal of attention is being given to longitudinal framing of ships. It is by no means a modern suggestion, for this subject very early engaged the attention of naval architects. On the northeast coast have quite recently been built vessels whose primary framing is longitudinal, both in the bottom, sides and decks. We refer to the Isherwood system, which, many naval architects believe, is destined to be largely used in the construction of certain classes of vessels, and especially petroleum tank steamers, in which, by its adoption, structural weight may be saved and construction simplified.

The northeast coast has been particularly occupied for many years past with vessels for the carriage of petroleum in bulk. Originally, nearly the whole of the petroleum shipped for British and European ports was carried in barrels, or in tin boxes cased in wood. Obviously the result was a considerable loss in space by broken stowage. This loss was augmented by serious leakage of the casks, usually amounting to about 2 per cent. The cost of the barrels and cases was also a serious item. It was sought to overcome these drawbacks by fitting in the holds and 'tween decks of an ordinary vessel tanks in which oil was carried. A number of old vessels were fitted on the Tyne and Tees with internal tanks shaped to fit the ship's side, but with about 2 feet spaces between the tanks and the shell plating.

Oil Carriage

In 1863 the iron sailing vessels were constructed for carrying oil in bulk, without internal tanks, the oil being in contact with the ship's shell and filling the various compartments. One of these was the Ramsey, of 821 tons, built in the Isle of Man, and two were built on the Tyne, viz., the Atlantic and the Great Western, each of 416 tons. These had center line and athwartship bulkheads. From some cause they were withdrawn from this trade and adapted for ordinary cargo, being possibly unsuited for carrying oil from the absence of expansion trunks, for it is recorded that to keep the tanks full the iron fore and main masts were filled a long way up with oil.

The first steamship specially designed for carrying oil in bulk was the Vaderland, built on the Tyne by Messrs. Palmers, in 1872. Her registered dimensions were 320.5 ft. by 38.5 ft. by 30.9 ft., her gross tonnage being 2,748. She was never engaged in the special trade for which she was designed—between Antwerp and the United States—as the authorities in Antwerp would not allow the cisterns to be erected for warehousing the cargo. In this vessel the engines were placed aft, and longitudinal and transverse bulkheads divided the vessel into oil-tight compartments. She had an inner skin, the space between the two skins being 26 inches at the center keelson, diminishing to 20 inches at the turn of the bilge, and extending to the height of the hold beams. Large oil-tight trunked hatches served for expansion. She was followed in 1873 and 1874 by the Nederland and Switzerland, in which vessels the machinery was placed amidships. These vessels also, for the reason stated above, were not employed in the trade for which they were built.

Early Oil Boats.

Messrs. Gray & Co., of Hartlepool, were early in the field in the construction of vessels of this class, having built the Bakuin in 1886. She was an iron steamer with the middle deck curved downwards toward the middle line, with air pipes fitted at the sides. She had a cellular double bottom; her engines were placed aft and the engine-room was lighted by electricity, and the cooking and heating was performed by steam so as to minimize the danger of fire. She carried 1,950 tons of oil when fully laden.

Although other northeast coast builders had at this period turned their serious attention to tankers, it is to Col. H. F. Swan, of Messrs. Sir W. G. Armstrong, Whitworth & Co., Ltd., that the principal credit is due in the designing and building of petroleum steamers without separate internal tanks. The first vessel built by this firm was the Gluckauf, in 1887. She had a mid line and transverse bulkheads, and the oil extended to the skin, a trunkway being fitted to each compartment for the expansion of oil. She was a vessel of 300.5 ft. by 37.2 ft. by 23 ft., her gross tonnage being 2,229. She had no double bottom, neither was it needed, as provision was made for filling each tank with water as the oil was pumped out, so ballasting and trimming the vessel. The result of Col. Swan's invention and enterprise has been that of the 561,500 gross tons of ocean tank steamers built in the United Kingdom for carrying petroleum in bulk 352,400 tons have been built on the Tyne.

Turbines.

We must on no account omit mentioning the remarkable vessel which was built at Wallsend in 1894 by the Parsons Marine Steam Turbine Co., Ltd.,—the world-famed Turbinia, a little steel craft of 100 ft. long and 9 ft. beam, which, fitted with marine steam turbine engines, maintained the amazing speed of 34 knots when steaming from Spithead to Southampton water. The experimental work of the Hon. C. A. Parsons on this vessel, together with many years' prior work, has led to the adoption of Parsons' marine steam turbine engines, first for torpedo boats and destroyers, and afterwards for the largest vessels of the royal war fleet, and for fast passenger steamships, including the two largest and fastest ocean-going passenger steamers, the R. M. steamships Mauretania and Lusitania. More recently a combination of reciprocating and turbine engines has been introduced.

While referring to marine engineers, it should be noticed that not only has the genius of the northeast coast district produced the marine turbine engine, but it also figured in the introduction of the triple-expansion engine. With this the name of the late Alexander Taylor is closely associated, who is the reputed inventor, and was at all events working concurrently with the late Dr. Kirk in its inception and practical application. Marine boilers for 150-lb. working pressure were first built on the Tyne to Mr. Alexander Taylor's design.

Special Types.

Messrs. Armstrong, Mitchell & Co., of Walker, early turned their attention to the building of cable-laying vessels, beginning with the Hooper (now Silvertown). Her dimensions are:—338.2 ft. by 55 ft. by 34.6 ft., gross tonnage 4,935. She was built in 100 working days, and launched in 1873. This was considered quite a record performance. Many other vessels of this class have since been built in this district by Messrs. Sir W. G. Armstrong, Mitchell & Co., and Messrs. Swan, Hunter & Wigham Richardson, Ltd.

In 1895 Messrs. Sir W. G. Armstrong, Mitchell & Co. built the ice-breaker Saratovskaia Ledokol and the ice-break-

ing ferry Saratovskaia Pereprava. The latter was fitted with a hydraulic elevator for raising and lowering railway carriages, trucks, etc., to suit the various great differences in the heights of water in the river Volga. Both were built in sections to pass the canal locks. In 1899 the famous ice-breaker Ermack, with engines of 12,000 horsepower, and propellers at each end, was delivered to the imperial Russian government.

Train-ferry steamers of large size and high speed have also been constructed, the latest being the Drottning Victoria, 354 ft. by 51 ft., gross tonnage 3,053, which attained a mean speed of 17½ knots on a four hours' trial. The steamer was built by Messrs. Swan, Hunter & Wigham Richardson, Ltd., for the Swedish government. As a matter of detail reference may be had to the system of joggling shell plating, which was introduced by Messrs Doxford and has since been largely adopted.

The Mauretania.

The Cunard quadruple steamship Mauretania, turbine driven, is one of the largest productions of the northeast coast. Her performance has been remarkably regular, and almost as punctual and reliable as a mail train, there having been a difference of only two hours five minutes steaming east, and three hours 35 minutes steaming west, between the fastest and the slowest of the 12 consecutive runs just now concluded extending over three and a half months, the distance steamed during that time being 34,958 nautical miles, and the average speed 25.56 knots over that mileage in all weathers.

The district has led the way, in modern times, in the introduction of improved machinery and appliances, such as overhead crane gantries, large glazed sheds for ship building with electric cranes working on and inside the roof, wire rope transporting gear to convey the material to and over the building berths with electric adjusting and hoisting machinery, etc.

The Blue Ribbon.

As is generally known, the northeast coast has been for a long time past the largest ship building district in the world. The district is maintaining its preponderance as a ship building center. From 1877 to 1908, a period of 32 years, the "blue ribbon" for the largest individual output has been won by the northeast coast builders 15 times (47 per cent), and the second place 20 times (62 per cent).

The variety of types of vessels produced is probably greater than in any other district; and it is only on the Tyne that in one great company's establishment the guns are made in addition to building battleships and cruisers, and in another the finished steel is made and the ships and engines built by the same company. Those who have most to do with the designing and superintendence of warships, large and small, and cargo and passenger steamships of the highest grade, know best to what a remarkably high standard of excellence in work and success in design ship builders and marine engineers of the northeast coast have attained.

Education.

A great improvement has been made in this, as in other districts, during the last half century, in the training and education of ship builders, especially during the last 25 years. The best theoretical and practical teaching is now available at the Armstrong college, Newcastle, and other institutions. The supply of competent naval architects and engineers is sufficient for any demand, and ship building and marine engineering are now exact sciences. Fifty years ago it was not so. It might then have been truly said of those engaged in building merchant ships, as it was said 50 years earlier still of those employed in royal dockyards, "Few have much education;" "as apprentices they serve seven years, no care is taken to teach them anything during that time, but their business as shipwrights." Merchant ship building was then carried on chiefly by "rule of thumb," science and mathematics were but little applied, great mistakes were made, and progress was slow. Serious mistakes and failures are now almost unknown, and progress is rapid and sure.

Doubtless we are largely indebted for the dissemination of knowledge to such institutions as are here represented; in which theory and practice go hand in hand to the betterment of both, and the advancement of science and of the world.

Attached to the paper was a table showing the total tonnage returns of the northeast coast, compared with the output of the United Kingdom and abroad (including men-of-war):—

Years.	Gross tons North-East coast.	Gross tons U. K., U. S., and France to 1881, thence the world's output.	Percentage.
1859-1863	403,800	2,515,300	16.0
1864-1868	666.900	3 924,000	17.0
1869-1873	1,103,900	3,629,900	30.4
1874-1878	1,230,600	3,998,600	30.7
1879-1883	2,264.300	4,822.600	47.0
1884-1888	1,480,400	3 246.000	45.6
1889-1893	3,045,100	5,895,400	51.7
1894-1898	3,094.300	6,178,110	50.0
1899-1903	4,184,100	8,124,100	51.5
1904-1908	4,133,600	7,994,500	51.7

The great rise in the output immediately following the five years ending 1868 is probably due to the opening of the Suez canal in 1869, and the conclusion of the Franco-German war in 1871. Since 1897 the figures include the tonnage of the shelter decks and erections, which probably gives a better idea of the amount of work turned out than the board of trade gross tonnage does.

A further table shows the builders who have secured the blue ribbon for tonnage output during the past 32 years:—

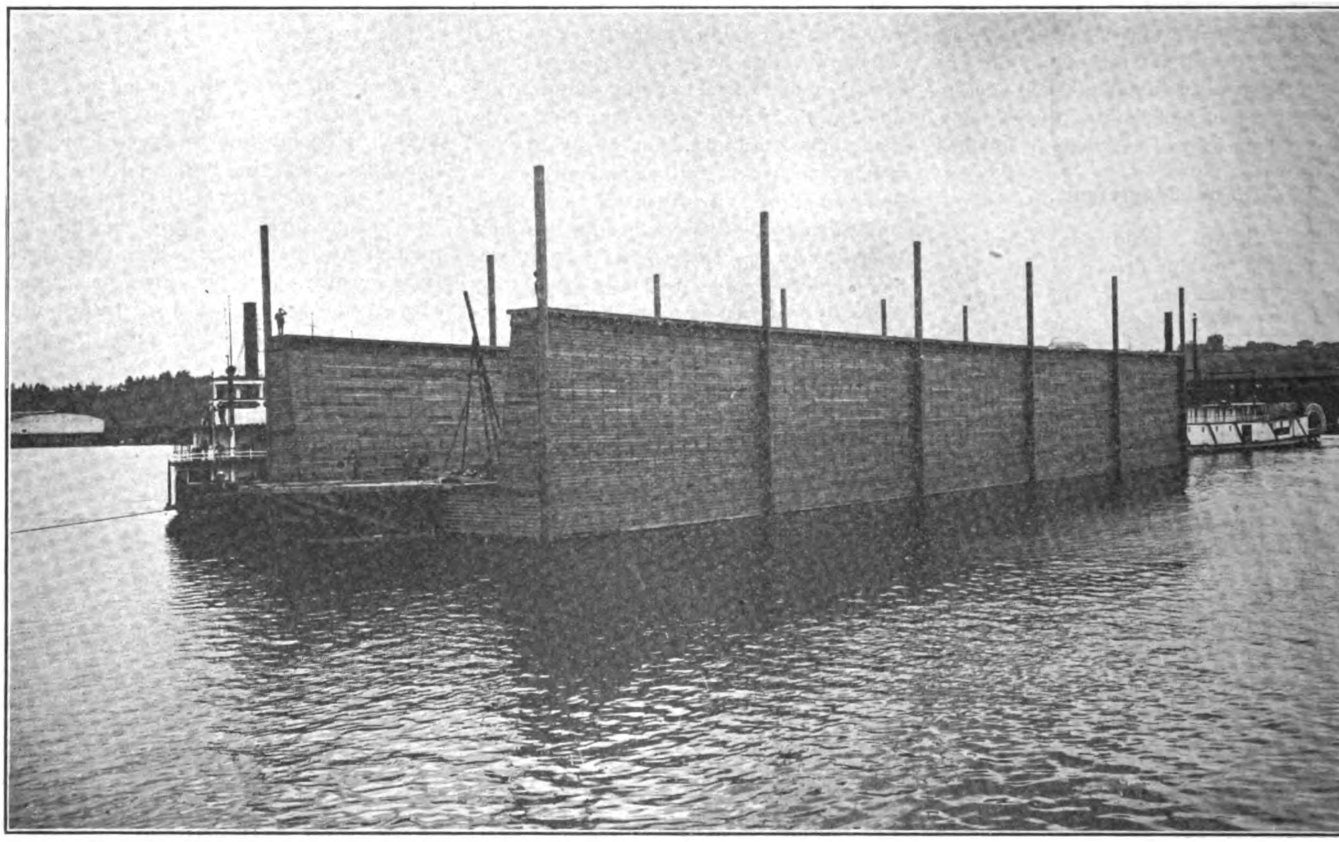
	First.	Tons.	Second.	Tons.
1877	Palmers	16,235	McMillan	11,535
1878	C. Mitchell & Co	24 722	Palmers	24,174
1879	Palmers	36,080	A. Leslie & Co	22,349
1880	Palmers	38,117	John Elder & Co	33,262
1881	Palmers	50,192	W. Gray & Co	32,033
1882	Palmers	60,379	John Elder & Co	31,686
1883	Palmers	61,113	Fairfield Co	40,115
1884	Fairfield Co.	32,400	Russell & Co	32.120
1885	Russell & Co	40,866	Palmers	25,057
1886	Russell & Co	29,843	Fairfield Co.	23,434
1887	Harland & Wolff	31,446	W. Gray & Co	30,243
1888	Palmers	47,076	Armstrong. Mitchell	32,541
1889	Palmers	64,669	Harland & Wolff	56,430
1890	Russell & Co	70,370	W. Gray & Co	64.253
1891	Harland & Wolff	92,429	W. Gray & Co	59,033
1892	Harland & Wolff	68,614	W. Gray & Co	59,810
1893	Harland & Wolff	65 660	W. Gray & Co	50,349
1894	Harland & Wolff	65,448	Russell & Co	56.964
1895	W. Gray & Co	63.086	Harland & Wolff	58,093
1896	Harland & Wolff	81.316	Sir W. G. Armstrong	54.157
1897	Harland & Wolff	84 240	C. S. Swan & Hunter	48,570
1898	W. Gray & Co	72,323	C. S. Swan & Hunter	68,696
1899	Harland & Wolff	82,634	W. Gray & Co	77,501
1900	W. Gray & Co	81,794	Harland & Wolff	73,897
1901	Harland & Wolff	92,316	W. Gray & Co	82,262
1902	Harland & Wolff	79,497	Workman. Clark & Co	75,932
1903	Harland & Wolff	10,463	Swan, Hunter & Co	66,452
1904	Russell & Co	73,689	Swan, Hunter & Co	73.592
1905	W. Doxford & Sons	86,632	Harland & Wolff	85,287
1906	Swan. Hunter & Co	126,921	W. Doxford & Sons	106.058
1907	W. Doxford & Sons	91,254	Swan, Hunter & Co	80,573
1908	Harland & Wolff	106.528	Swan, Hunter & Co	61,580

The legislature of the state of Washington passed the Duwamish river improvement bill August 13. This bill provides for extensive improvements to the Duwamish river and the harbor of Seattle. The work contemplated includes dredging and straightening about 10 miles of river channel and providing turning basins.

Floating Dry Dock for the Oregon Dry Dock Co.

IN 1903, the Port of Portland Commission built a 10,000-ton sectional floating dry dock for Portland harbor. In 1907, only five of the vessels docked on this dock registered over 2,000 tons gross. In 1908, there were only six vessels of 2,000 tons gross or over docked. On the other hand, in 1907, 69 per cent, and in 1908, 68 per cent of the total dockages were vessels under 1,000 tons gross. In view of this and of the well known fact that small vessels can be more quickly and economically handled in a small than in a large dock, the Oregon Dry Dock Co. was organized last year to build a medium size modern floating dry dock, particularly adapted to this class of ship, and Fred A. Ballin, naval architect of Portland, was commissioned to design a dock to meet these conditions. We are indebted to Mr. Ballin for the drawings and details of construction which are presented herewith.

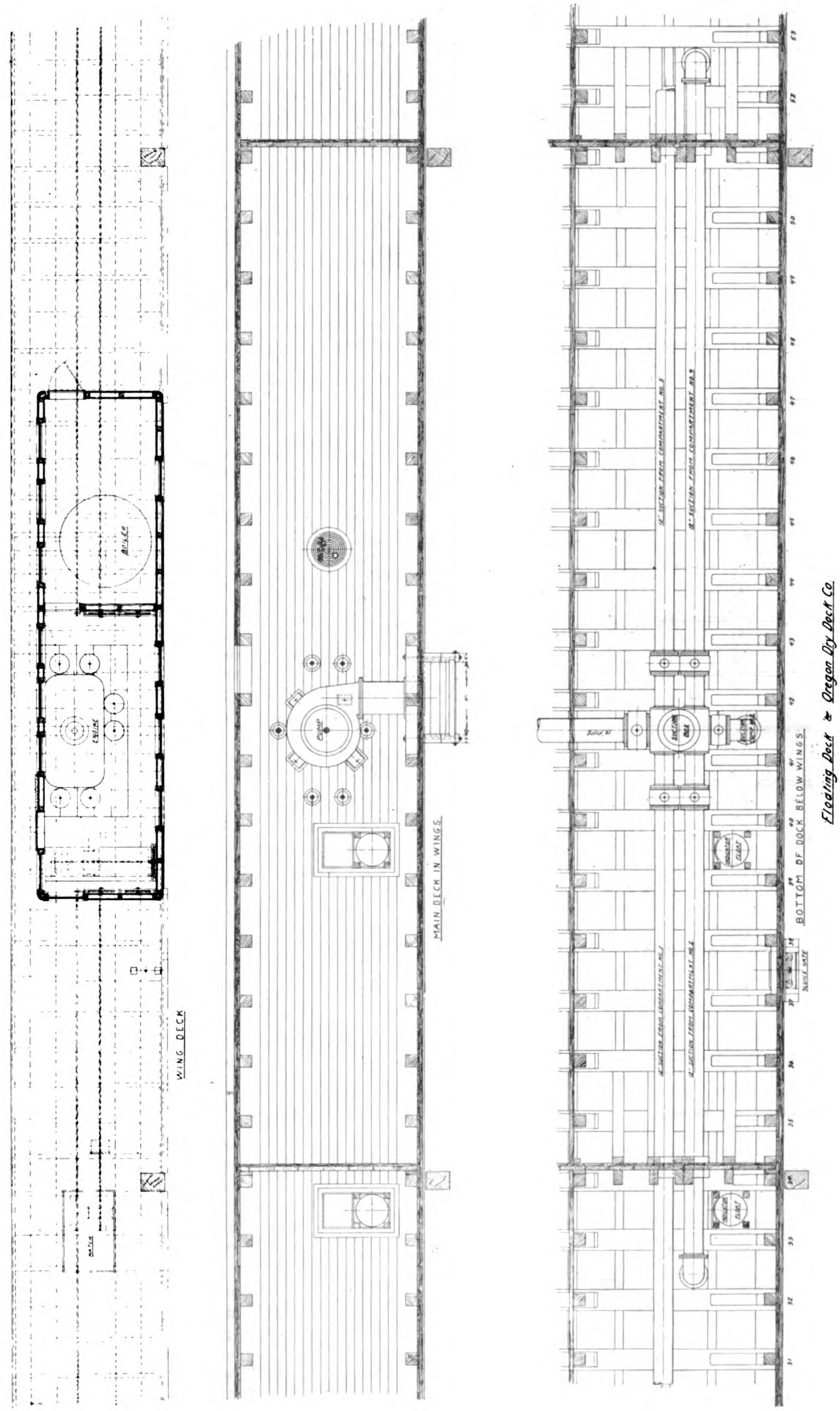
Conditions demanded a dock that would safely handle any vessel up to 300 ft. in length, 40 ft. beam and 18 ft. draught and that could take care of average sailing ships, of which a large number visit Portland annually. The dead weight of steamers of the size mentioned varies between 2,500 and 3,000 tons, while very few sailing vessels exceed 300 ft. in length or 2,000 tons dead weight. It was therefore decided to build a dock 286 ft. in length on the pontoon and 348 ft. over the aprons, with a clear width on deck of 56 ft. and at the top sides of 64 ft.

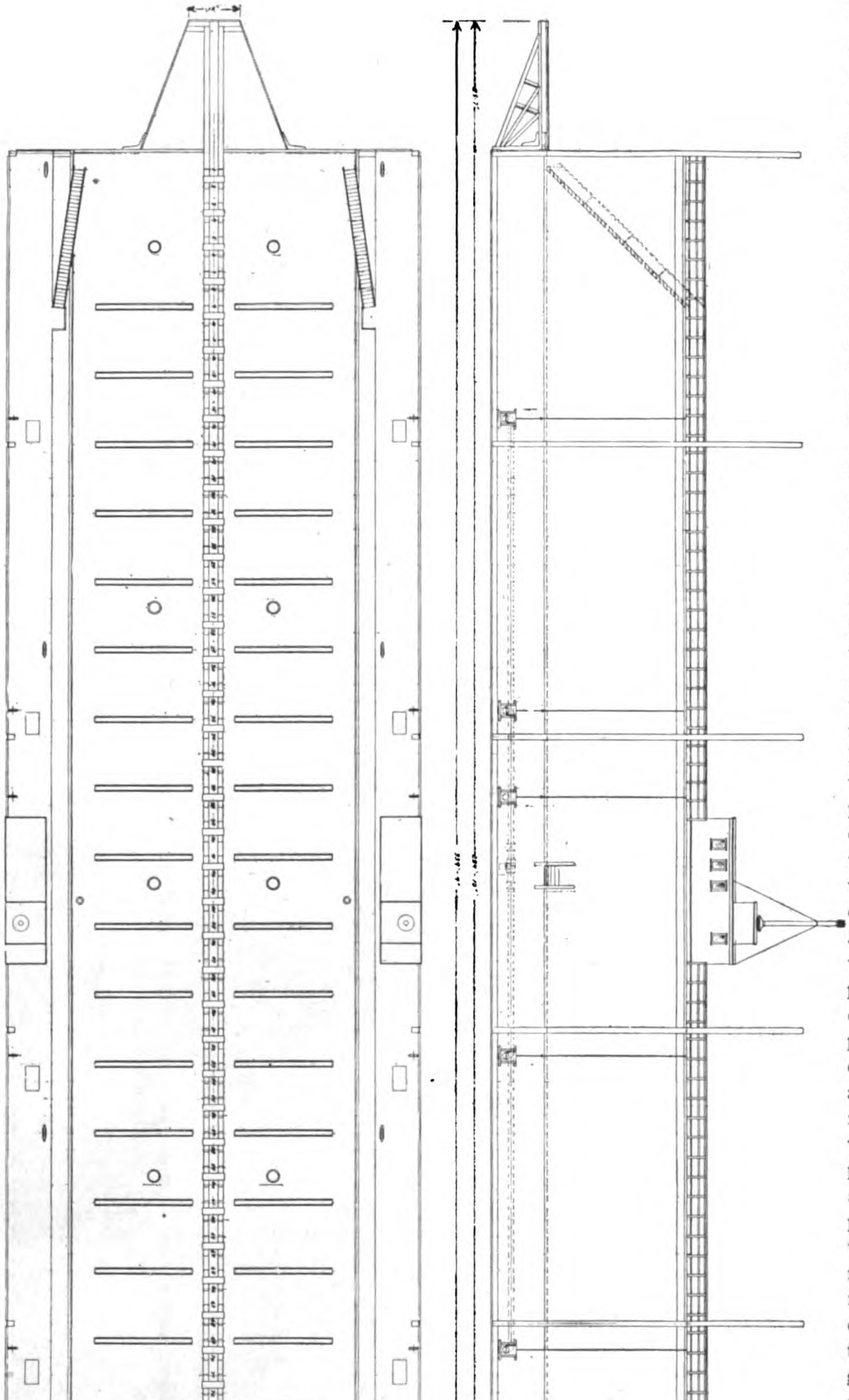


NEW FLOATING DRY DOCK OF THE OREGON DRY DOCK CO. THIS EXTERIOR VIEW SHOWS THE SIZE OF THE DOCK AS COMPARED WITH AN ORDINARY STERN WHEEL RIVER STEAMER.

After a thorough study of the local conditions, a wooden dock was decided upon, because on the west coast the cost of steel construction as compared with wood is so high that the steel dock would be considerably more expensive, even taking into consideration its longer life. Furthermore, experience has shown that the pontoons of wooden docks which have been in service as long as 50 years are still sound and in good condition, although the wings usually decay much more rapidly, as is to be expected. The pontoon of the dock under consideration has a molded depth at the center of 10 ft. and at the sides of 9 ft. 1 in. The total height of wing walls is 37 ft. 6 in. The single pontoon is 286 ft. long, 76 ft. 8 in. extreme beam and, as already noted, 10 ft. deep at center. It was not necessary to provide for self-docking as, if required, the whole structure may be docked in the large dock belonging to the Port of Portland, which is public property and open to the use of anyone on payment of the regular rates. This consequently simplified the design and made a sectional dock unnecessary.

At 32 ft. draught, which will accommodate ships drawing 18 ft., allowing 4 ft. for keel blocks, the gross displacement of the dock is 10,170 net tons. The net displacement and buoyancy is 7,640 net tons. With the deck of the pontoon just out of water, the maximum lifting capacity is 3,000 tons. The unsubmerged dead weight amounts to about 3,000 tons, having a submerged buoyancy of about 640 tons, requiring about 500 tons of ballast and machinery to balance the dock at 32

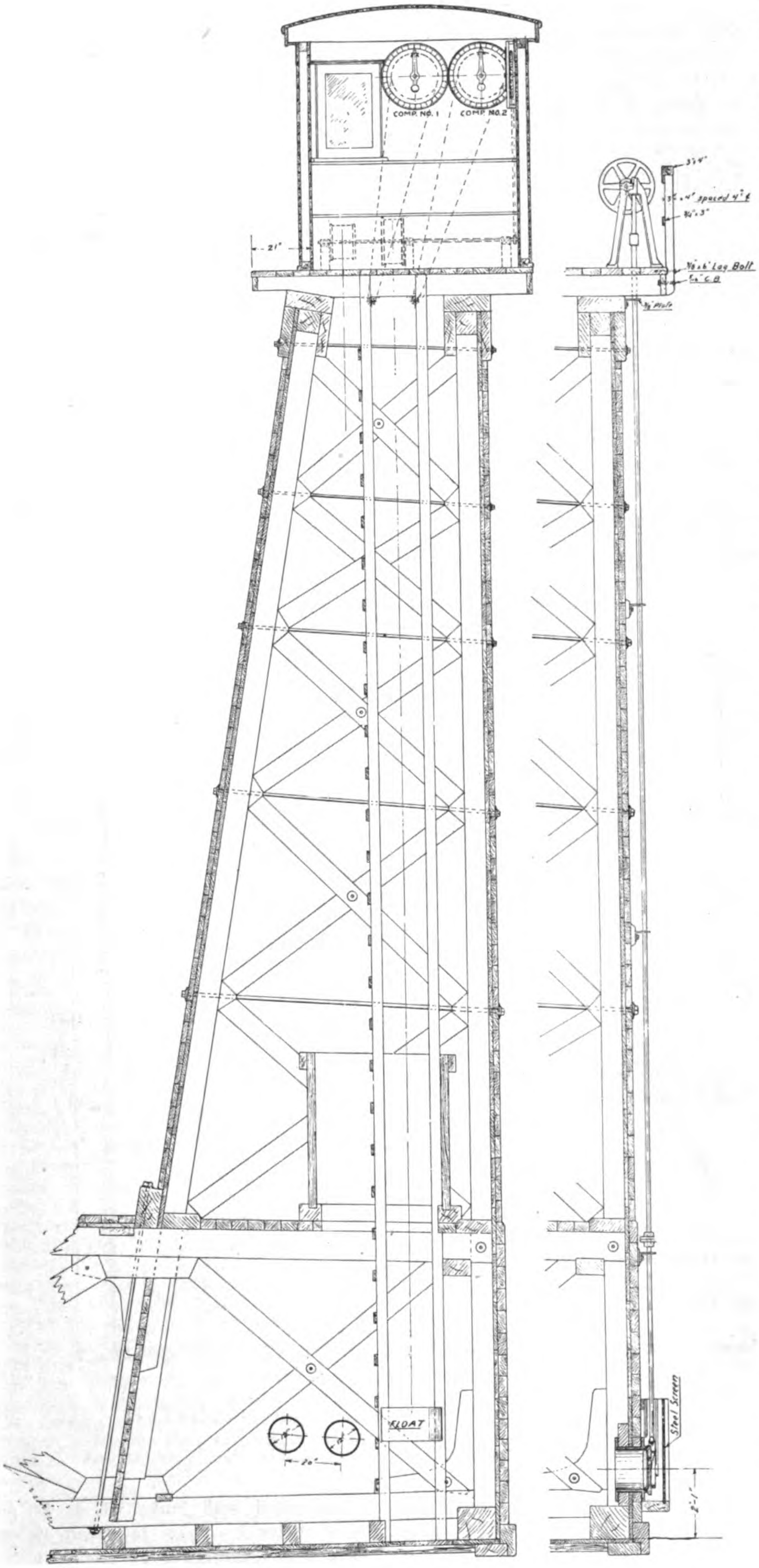

WING DECK
MAIN DECK IN WINGS
BOTTOM OF DOCK BELOW WINGS
Floating Dock & Oregon Dry Dock Co



General Plan of Floating Dock for Oregon Dry Dock Co.

ft. draught. The pontoon frames are spaced 3 ft. 4 in. apart. The trusses are built of diagonals and vertical struts with natural knees at bulkhead corners. Each truss is further stiffened by two long 10 x 10 in. struts leading from each side of the central bulkhead to the wash bulkheads under the inner wing walls. Over 1,000,000 ft. of lumber and 150 tons of metal fastenings were used in the construction of the dock. Wherever possible, both in the pontoons and in the wings, bolts were used and provision was made for the removal and renewal of the construction members. Strain sheets were calculated for the varying conditions and compression strains were limited to 1,000 lbs. per sq. in. with, and 200 lbs. across, the grain of the wood. All water tight work was made double thickness, with heavy felt between the courses. The center line bulkhead was laid up with double diagonal 3 in. tongued and grooved plank, and stiffened by 8 x 8 in. uprights and knees with heavy stringers at top and bottom. There are four transverse bulkheads extending up to the top of the wing walls, giving ten water tight compartments in the pontoon and five in each wing wall. The wash bulkheads under the inner wing walls are not water tight. The wings are fitted with overflow boxes, preventing more than 5 ft. of water being left in the wing walls when pumping from the main pontoon begins. The pumping machinery consists of two 20-in. centrifugal pumps, driven by double engines located on top of the wing walls. The pumps are on the pontoon deck and are connected to a suction box, as shown, with a foot valve between. Suction pipes 12 in. diameter lead from the suction box into each of the five compartments of the pontoon, with a gate valve in each, controlled from engine room on top of the wall. Pumping from all the compartments on one side of the dock can be conveniently controlled from the centrally located engine house. The suction boxes on each side of the dock are cross-connected by a 16-in. pipe with gate-valve cutout, so that the entire dock may be pumped with either pump. A priming box is built over the discharge of the pumps outside of the dock. Steam for each engine is furnished by a separate vertical boiler.

The wing compartments have communicating valves and each compartment is provided with flooding gates operated by rack and pinion from the top of the wing walls. A float in each compartment is connected to a dial indicator located in the engine room,



SECTION LOOKING FOR'D AT FRAME No. 39. SECTION AT SLUICE GATES.

SECTION OF FLOATING DOCK FOR OREGON DRY DOCK CO.

where the engineers have full control of all suction valves.

The dock was successfully launched in July last and placed in service late in August. It will be berthed alongside of the plant of the Willamette Iron & Steel Works in North Portland, with whom the Oregon Dry Dock Co. has made arrangements for the use of its tracks, air tools, traveling cranes and other facilities for expeditiously executing repair work on a vessel in dock.

DIPPER DREDGE FOR MONTREAL CONTRACTORS.

The Vulcan Steam Shovel Co., Toledo, have recently built a 1½-cu. yd. dipper dredge for Laurin & Leitch, No. 5 Beaver Hall Square, Montreal, Que. The new dredge is at present being used to dredge a channel for the intake pipe to the crib that is being built in connection with the city of Montreal water works.

The hull is 80 ft. long by 40 ft. wide and 7 ft. deep, and was built on the ground after plans furnished by the manufacturers of the machinery. The main engines are double 10 in. x 12 in., piston valve, reversible, without links, the valves being so set as to give maximum efficiency in the go-ahead position. The crank shaft is of hammered iron, and the pinion is of cast steel with cut teeth.

The hoisting gear is cast steel with cut teeth. The hoist drum is of cast iron, brass bushed. It runs loose on shaft and has wide-faced flanges riveted to each end for friction and lowering brake bands. The drum has finished grooves for the cable. The hoist friction is of the outside band type, wood lined and controlled by a steam ram operated by a hand lever at the engineer's stand. The lowering brake is also of the outside band type, wood lined, and is controlled by means of a foot treadle at the engineer's stand. The drum shaft is of hammered iron supported in strong cast iron babbitted bearings with adjustable caps.

The swinging engines are 8 in. x 9 in. duplex, slide valve, reversible, with the bed cast in one piece. The crank is forged and the crank pin and cross-head pin bearings are of bronze. The swinging engine pinions are of forged steel with cut teeth. The intermediate gear is of cast steel with cut teeth. Swinging gear is of cast steel, with cut teeth and is riveted to drum. Swinging drum is of cast iron running loose on shaft and has finished grooves for cable.

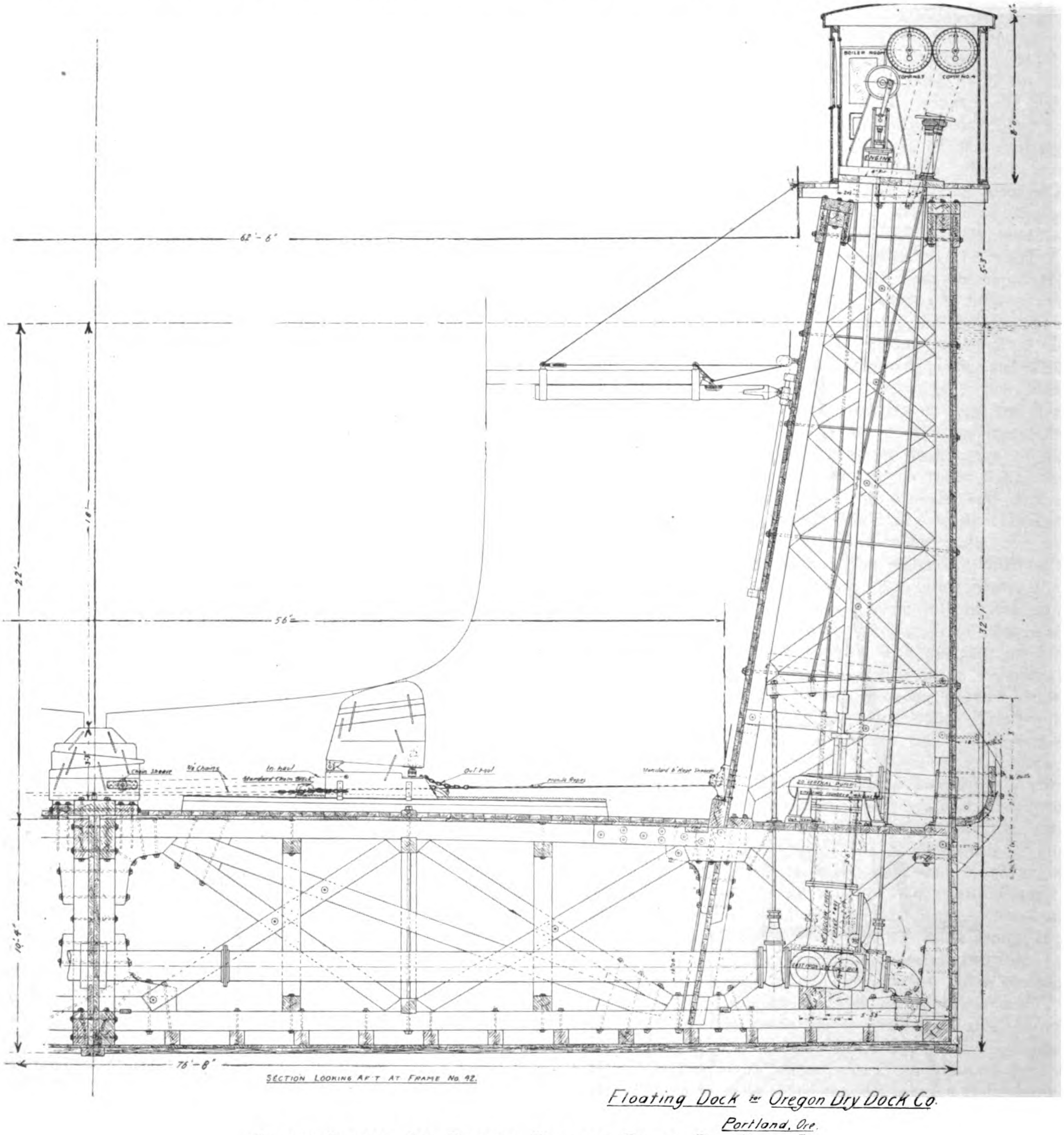
The backing gear is of cast steel with

cut teeth and is driven from the main engines. The drum is of cast iron with brass bushings and runs loose on shaft. It is driven direct from the gear by means of an outside friction band, handled from engineer's stand through hand lever and connections.

The bow anchors are raised by means desired depth. The stern anchors are of the walking type with cradle and guide. These are operated by hand power. Two winches are provided on the deck, which are driven by gearing and clutches from the backing drum shaft.

The "A" frame is built up of channels, plates and bars with a cast steel between. The whole circle is thoroughly and substantially framed and has proper provision for connection to the boom and to the swinging cable. The circle is carried at the deck level.

The boom is of steel plates and shapes riveted up in the most substantial manner. Shipper shaft is of cast steel and



SECTION LOOKING AFT FLOATING DOCK FOR OREGON DRY DOCK CO.

of rack and pinions, the pinion driven through train of gears and steel sprocket chain with a friction device on a shaft under the deck, which in turn are driven by the backing shaft. The bow anchors are provided with strong cast steel locks for holding them at any head, feet and steps. The head is provided with cast iron yoke brass bushed. Boom and guide back are of wire cable. The swinging circle is 16 ft. in diameter, of structural steel with cast steel brass bushed center, working in a steel step or base casting with bronze collar is furnished with brake wheels 54 in. in diameter by 5 in. face with wood lined bands controlled by a foot pedal to the cranesman's stand. The boom is 38 ft. long, center to center, and is stepped at the bottom in a strong steel casting, brass bushed, which works on

a steel base plate with bronze washer between. All hoisting and swinging sheaves are of cast steel, brass bushed, with pins of ample size to prevent undue wear. The dipper handle is of wood, steel armored.

The dipper is of 1½ cu. yd. capacity, square, with four tool steel teeth, cast steel back, cast steel lip, lugs, and forged bail, braces and hinges.

The boiler is of the locomotive type, 66 in. diameter by 14 ft. long, covered with magnesia boiler covering, and is supplied with water by means of injector and steam feed pump.

Oil is supplied to all engines by means of a Hills-McCanna force feed lubricating pump, insuring constant and sufficient supply of oil at all times. All sheaves, bearings, etc., are fitted with dope cups of ample size. Each engine is also furnished with a hand oil pump and the ram and the pump are furnished with a lubricator.

It will be seen from the above description that the machinery is large enough to carry a 2½ cu. yd. dipper for ordinary work, but inasmuch as the material at present being excavated is rock, the smaller dipper was substituted. The smaller dipper also better fits the present work.

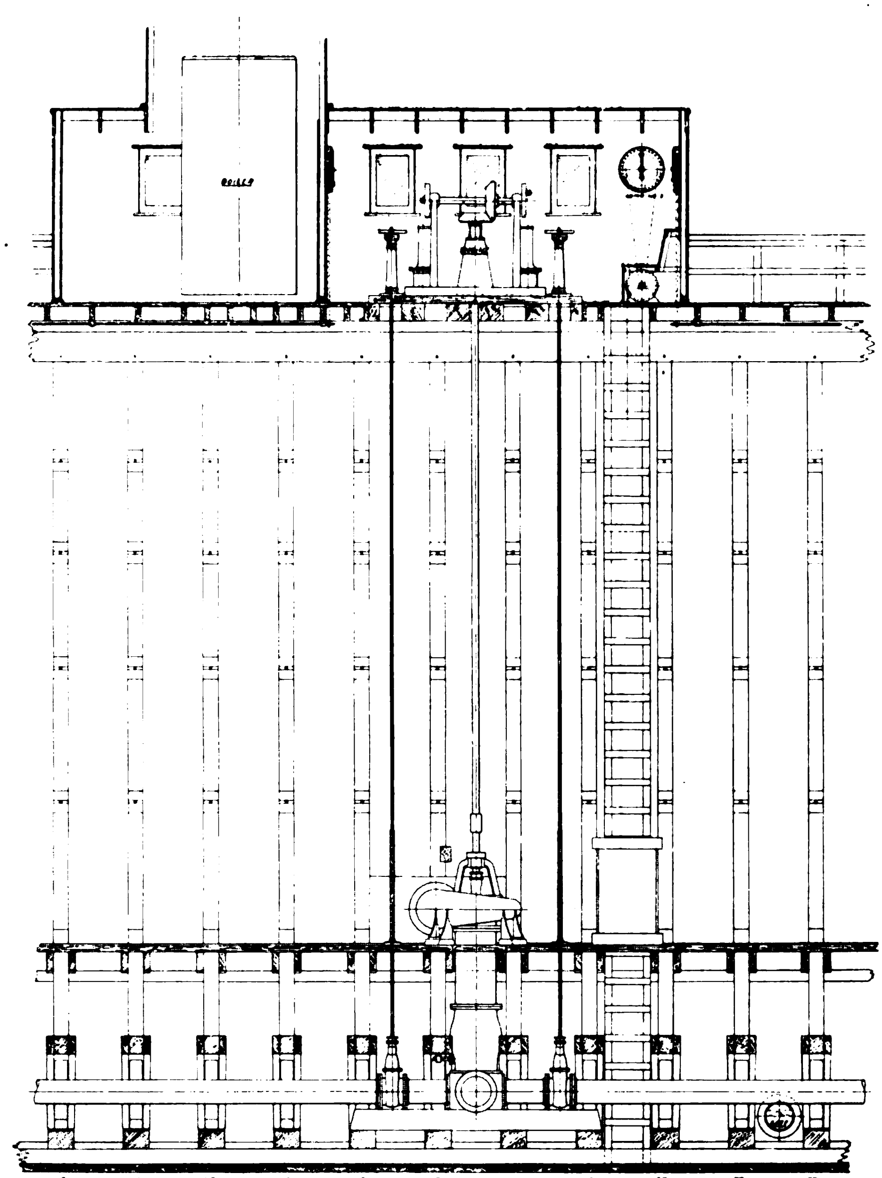
THE PORHYDROMETER.

An instrument to which the above name has been given has been attracting more or less widespread attention in Great Britain recently, and is thus described:

This invention is an instrument for weighing the dead weight placed on board or removed from any ship, barge or other floating vessel to which it is fitted. The instrument is based upon the principle that a body floating in a liquid of whatever density displaces a quantity of that liquid exactly equal to its own weight, and by its application the vessel is transformed into a weighbridge or weighing machine. In the center of the vessel a vertical tube is fitted extending from well below the light draught water line to well above the load line, and connected by a pipe with the outside shell of the vessel, so that when the valve or cock is opened the water in which the vessel is floating has free access to the vertical tube and rises in it to exactly the same level as outside the vessel, the water or liquid, both in the tube and outside the vessel, being thus of the same density. Inside the vertical tube is fixed a vertical float called the aerometer, which, having exactly proportionate horizontal areas at the various immersions to the areas of the planes of flotation at the present draughts or immersions of the vessel, has an exactly similar displacement and reduces the enormous weights dealt with to a measurable quantity. The aerometer being immersed in the same liquid to the same extent as the vessel itself by its consequent exactly proportionate displacement loses an amount of weight exactly equal to its displacement. This loss of weight disturbs the balance of levers and is exactly registered or counter balanced by moving the weights along the steelyard, giving a correct reading of the weights placed on board the vessel, and *vice versa* weights removed. The tube being fixed in the center of the vessel neither transverse inclination nor change of trim will affect the accuracy.

To the ship owner, charterer and shippers, the advantages of this instrument are summed up as follows:—the cargo is accurately weighed in one operation; the captain or officials in charge are at all times in a position to ascertain the weights on board; coal taken at a coaling port can be weighed correctly; in case of leakage through collision, grounding or any other cause, the element of danger, and capacity of the pumps to cope with it, can be accurately gaged and the course regulated accordingly; by weighing total cargoes in one operation, or parcels of goods loaded or discharged by themselves, when they are completely placed on board, or taken from the vessel, a great saving in cost is effected; the density of the water does not affect the accuracy of the instrument. The porhydrometer can be fitted to any vessel of any type, whether large or small, or for the sea, river or lake service. The Italian government has decreed that the customs shall accept as correct the weight of cargoes measured by the porhydrometer. This means that instead of a ship-owner paying 23 centimes per ton for the customs' weighing dues he has only to pay 8 centimes, saving nearly 200 per cent in Italian ports. In the case of leakage, the porhydrometer has attached to it an electric bell, so that when a leak is sprung a warning is given by the ringing of the bell. This done, the captain of a ship can calculate what port he can make and whether or not to abandon his ship.

So far as application to ships for



Floating Dock & Oregon Dry Dock Co.
Portland, Ore

SECTION THROUGH WINGS LOOKING OUTBOARD FLOATING DOCK OF OREGON DRY DOCK CO.

lake service is concerned, it is doubtful if the device wou'd find any very extended use, inasmuch as the question is materially complicated by the handling of water ballast. As is well known, the bulk carriers seldom have all their water ballast out before beginning to load, and, conversely, they almost invariably have run in a considerable amount before the unloading is comp'eted, so that when the last bushel of grain or the last ton of coal or ore is out, the ship is immediately ready to leave port.

Thus, either the handling of cargoes or handling of water ballast would have to be temporarily suspended while the other was going on, in order to make use of the perhydrometer.

Lake Shipyard Methods of Steel Ship Construction

By Robert Curr.

Reaming and Countersinking.

THIS article deals with the work on the ship after the plates and shapes are bolted up.

On the great lakes after the plates and shapes have been properly bolted together a gang of men follow up and examine the holes, and those unfair are reamed out so that a rivet fits into the hole, as shown by Figs. 66 and 67.

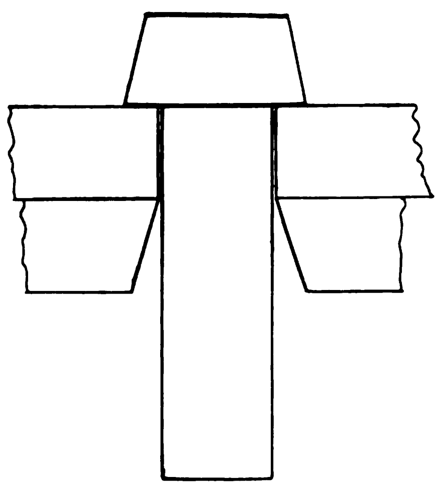


Fig. 66.

Fig. 68 shows what might be termed a perfect piece of work ready for riveting and Fig. 69 same riveted up.

Work of this kind is not always obtained which makes the perfecting of the work on the vessel by reaming and countersinking an important matter.

Fig. 70 shows sections of plates punched and countersunk as they leave the shop.

A, C, E, G and I are the countersunk places, and B, D, F, H and K are the punched plates.

These plates when put together, if a perfect fit, will look like Fig. 67. The dotted line "a" shows the diameter of the hole of the drilled plates which is smal'er on the underside "a" than the actual rivet hole when punched as shown by the heavy lines. The hole when punched is larger on the underside of the plate because of the die being larger than the punch. This is governed by the style of rivets used. If they are of the thick neck type shown by Fig. 67 the die in the punch machine is made to correspond to same.

The larger side of the hole is termed the burr side because it leaves a rough edge on the plate and makes it impossible to leave a close fit of the material when laid together. The putting together of the materials must be done by having the smooth surfaces laid together.

The materials which are countersunk may be punched with a very large die thus making the countersinking much easier.

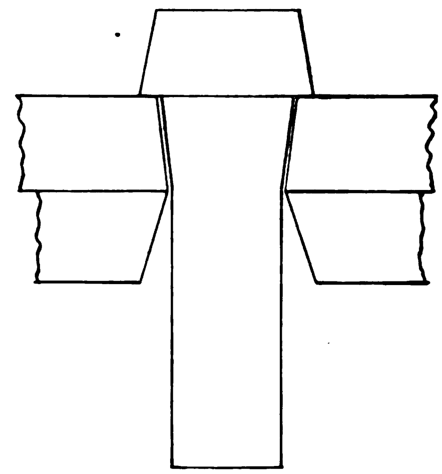


Fig. 67

Fig. 71 shows two p'ates riveted together where the plates have been reamed out one-sixteenth of an inch and the rivet driven to fill the hole. The shaded part "A" shows a vacancy left because of the hole being punched with a die one-eighth of an inch larger than the punch.

In order to have perfect work the hole should be reamed out a size larger and a larger rivet used as shown by dotted lines C, D, E. If the hole is

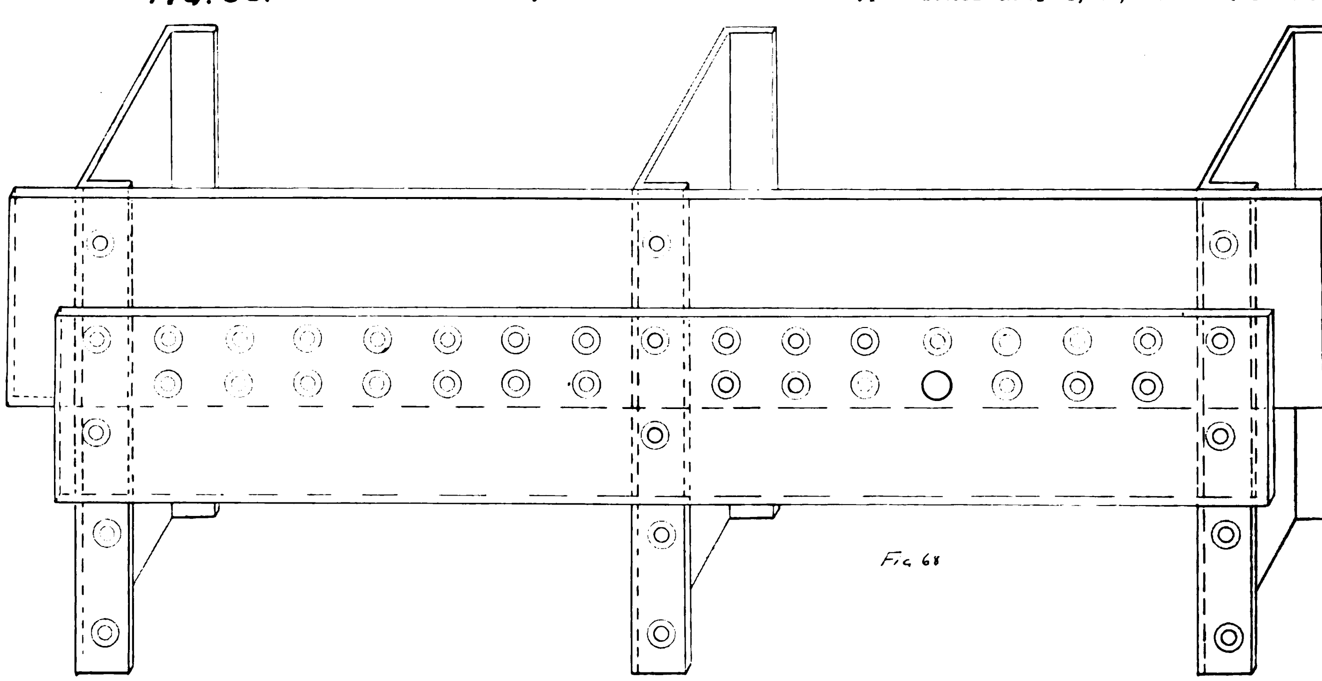


Fig. 68

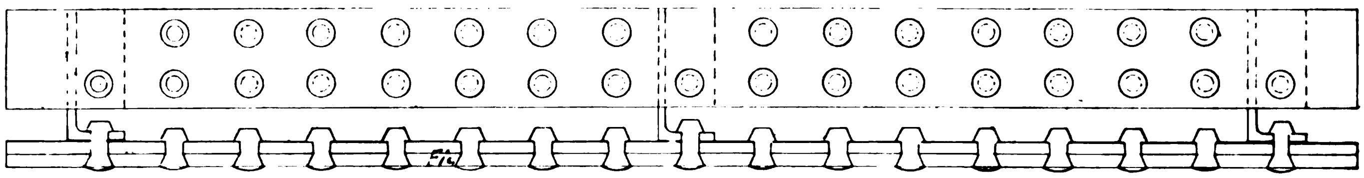


Fig. 69.

not recountersunk as shown by C, D, E, it will make a short countersink as shown by C, B, F and is not desirable for good work.

This case Fig. 71 is only likely to occur where the holes in the p'ates are punched a size less than the diameter of the rivets to be used.

Fig. 72 shows what is more likely to happen and also a mild case.

There being less metal on the countersunk plate this part as a rule is removed thus decreasing the amount of countersink desirable to make good work.

A-Fig. 72 shows the part removed and the heavy line shows the length of the countersink when reamed.

The plates B, D, F, H and K show a projection over the countersunk plates A, C, E, G and I on the opposite side of the hole.

If this were all the reaming needed to make fair work there would be no objections raised, but Fig. 73 shows cases which do happen. The holes are half blind as shown by dotted lines. The dotted part is reamed off, the full lines showing the shape of the rivet when finished.

The hole under the head of the rivet is left untouched but the rest of the material is c'eaned away by slanting the reamer until it touches the outside plate.

The shaded part shows a vacancy left after the rivet is finished.

Fig. 74 shows a specimen where the burr side of the plate is laid against the smooth side of the countersunk plate which, practically speaking, is punched on the wrong side.

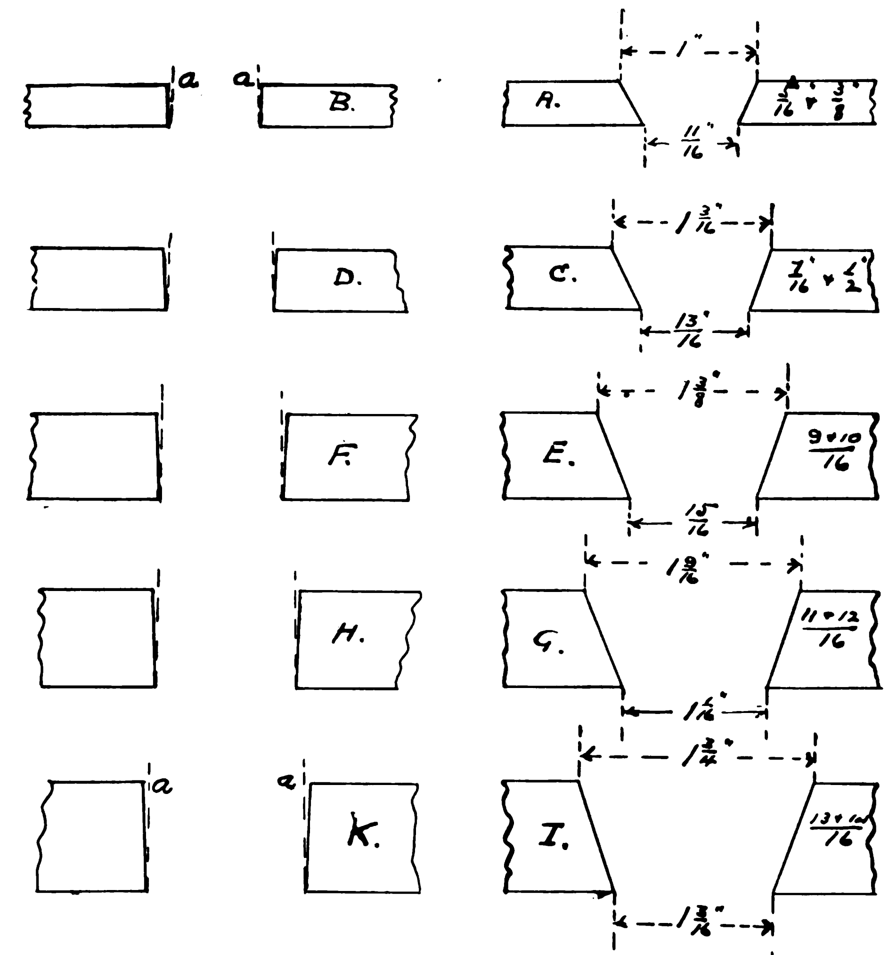


Fig. 70.

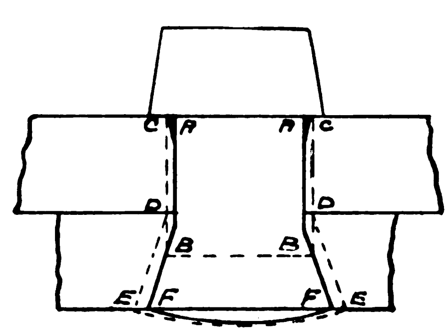


Fig. 71.

The shaded parts show the vacancy left when the rivet is finished. This is overcome by reaming the ho'e and putting in a larger rivet as shown by Fig. 71.

Fig. 75 shows a specimen of three thicknesses of plates; the shaded parts show vacancy left when the rivet is finished. This can be overcome by punching the middle plate a size less, and reaming out the hole after the three thicknesses are put together.

Where the rivet head covers the hole one may be deceived in the quality of the rivet when finished, but on the outside where the countersink is reamed off, the small or defective countersink can always be detected.

This is the most distressing part of the whole work for the rivets must be cut out and the plates recountersunk

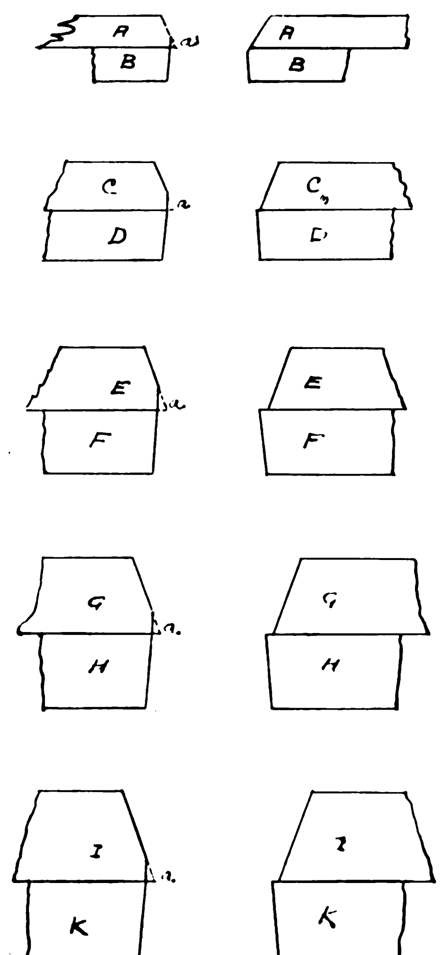


Fig. 72

as per rule. The shipbuilder as a rule does not know of this and the foremen are powerless in preventing the putting in of rivets in these holes because as a rule the riveters are fo'lowing up close behind the reamers.

The mold system of w rk creates a greater percentage of unfair holes than

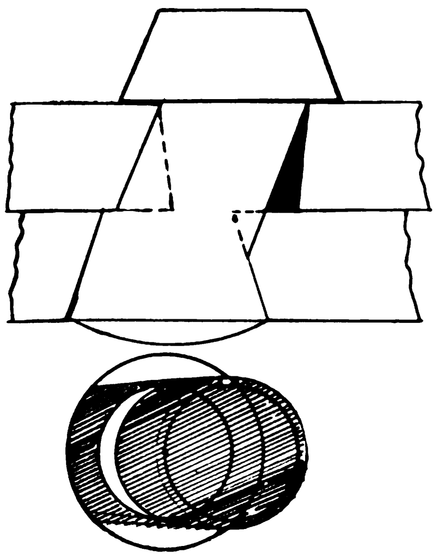


Fig. 73.

the old style of lifting the plates from the ship which, of course, increases the cost of reaming. The extra cost in reaming is a small matter compared to the advantages obtained by the m ld

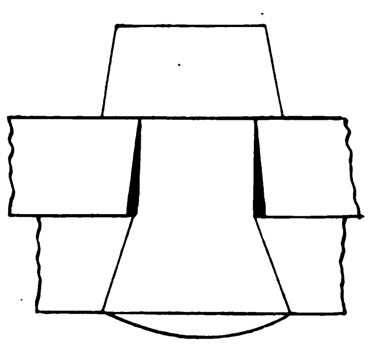


Fig. 74.

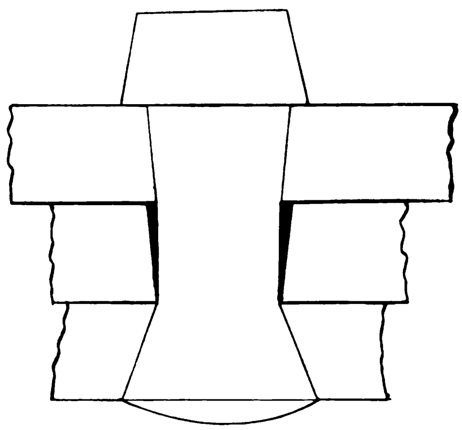


Fig. 75.

system and a tool like a combined reamer and countersink must be a great saving in time at the same cost as compared with the changing of tools to do countersinking.

NEW FERRY FERDINANDO GORGES.

The Bath Iron Works, Bath, Me., has recently completed the steam car ferry Ferdinando Gorges for the Maine Central Railroad's service on the Kennebec river between Bath and Woolwich.

The hull and machinery of the Ferdinando Gorges were designed and built entirely at the Bath Iron Works. She is 243 ft. in length over all, 240 ft. long on deck, 72 ft. beam over guards, 47 ft. molded beam, and 17 ft. 6 in. deep. She has four water tight bulkheads. There is a comb'ned length of trackage of 720 ft., there being three tracks on the deck.

The ferry has independent side wheels 29 ft. in diameter with buckets 3 ft. wide and 8 ft. long, sheathed with iron. The wheels, like the remainder of the vessel, are of especially heavy construction, she being obliged to cope with ice a large part of the year. Each wheel is dr'ven by a double engine with two cylinders of 26 in. diameter by 36 in. stroke. These engines are located in her hold and the power is transmitted to the paddles by pinions 49¾ in. in diameter on the crank shafts through gear wheels on the paddle sh ifts 16 ft. in diameter. The crank shafts are of 10½ in. diameter and the paddle shafts are 12 in. in diameter.

The Gorges is fitted with four single-ended Scotch boilers 13 ft. 6 in. diameter by 12 ft. 7½ in. long, and there are three Morrison furnaces. The working pressure is 150 pounds. Each boiler is fitted with an independent circulating pump of the duplex type, 4½ in. x 2¾ in. x 4 in.; one circulat'ng pump 9 in. x 9 in.; one 10 in. x 17 in. x 15 in. vertical double-acting twin air pump; one 10 in. x 6 in. x 10 in. duplex fire pump and two 7½ in. x 4½ in. x 10 in. duplex feed pumps. The condenser is 5 ft. in diameter and 9 ft. long.

A 7½ kilowatt generator has been installed, equipped w'th a Curtis turbine, for supplying electricity for lighting.

The only structures above deck are the steel paddle boxes, a storeroom for life preservers and a lavatory for the use of the crew. A steel bridge has been erected at each end of the steamer with a pilot house in the center of each. The bridges span all three tracks and are connected by a fore-and-aft gangway for the convenience of the officers and crew.

The vessel is strong enough to carry the heaviest rolling stock of the Maine Central railroad, as the three tracks are supported by s'x heavy girders supported by pillars and running the entire length of the boat with the exception of the boiler room, where the girders span the boilers transversely. In the engine room fore and aft girders of long span are built in over the engines.

There is a rudder at each end of this double ended boat, which is operated by a steering wheel in the p'lot house at the opposite end. Each rudder is connected to a steam steering engine made by the Hyde Windlass Co., of Bath. The valves of these engines are worked by shaft and gear transmission to their pilot house wheels. The rudder on the forward end is to be locked by means of a fork operated by screw gear on the deck.

The ferry is provided with the usual locking devices for holding the vessel fast to the transfer bridge apron and there are four h'tching winches of the Hyde windlass type. A hand capstan was also supplied by the Hyde Windlass Co.

Especial care was given to the design of the steamer, especially at the ends, owing to the fact that she must be an efficient ice crusher. She has been fitted with two 20-ft. life boats and a 14-ft. working boat, anchor and chain, besides miscellaneous requirements of the United States Steamboat Inspection service, all of wh'ch have been furnished complete by the builders.

TORPEDO BOAT DESTROYER PARAHYBA.

The Parahyba, the sixth of the ten torpedo boat destroyers ordered by the Brazil'an government, successfully passed her official full speed trial on the Skelmorlie mile at the mouth of the Clyde on Tuesday, June 29. The contract speed of these Brazilian destroyers is 27 knots, and the Parahyba obtained a mean speed of 27.29 knots. The trial, which was under the supervision of Capt. Bartholomeo Francisco de Souza e Silva and Capt. A.

Rosoure de Almeida, representing the Brazilian naval commision, and Capt. Affonso de Fenseca Rodrigues, the commander of the vessel, passed off without the slightest hitch, and the Brazilian authorities expressed themselves as being very highly satisfied with the result. The Parahyba was built by Yarrow & Co., Scotstown, Glasgow.

The Steam Turbine and the Reciprocating Engine for Marine Propulsion.*

By Ira N. Hollis.[1]

THE chief difficulty in the way of the steam turbine has been the screw propeller. Certain sacrifices in efficiency have been necessary in adapting the two to each other. While the turbine can be designed for low speed, its size and weight then run up too much for marine practice and it no longer compares favorably with the reciprocating engine except in economy. The number of stages in the Parsons machine grow greater as its rotative speed grows less, so that the casings and disks stretch along the shaft inordinately. The inventor found this true even for the high speed at which the turbine was run, and he placed the successive groups of stages in different casings on separate shafts as explained before. The Curtis turbine on the other hand, is usually increased in diameter for low rotative speed. This adds rapidly to the weight of the shaft and becomes prohibitive below a certain speed. We thus have the curious paradox of more turbine for low speeds than for high. Up to this time, no marine turbine has been designed for the low rotative speed of the reciprocating engine of freight ships.

Given, then, a limit of weight for the power demanded by a ship, the turbine requires for economical performance much higher rotative speed than the steam engine. Its whole efficiency is dependent upon high speed unless excessive weight and complication are permissible. The screw propeller is exactly the reverse. It must be run at low speed to avoid great frictional and slip losses. A compromise then follows by which both the propeller and turbine are sacrificed for a speed at which they work together with greatest economy. The truth is that erroneous conclusions are easily reached by separating the two in comparing the performance of the ships equipped with different types of propelling apparatus. The prime mover and the propeller must inevitably be treated as a unit.

Advantage of Reciprocating Engine at Low Speed.

Another consideration is that the turbine falls off more rapidly in efficiency than the steam engine as the speed decreases. For this reason, it is not specially adapted to war vessels, which usually steam at only half speed. Cruising turbines have been added by Mr. Parsons, which is only another method of increasing the number of stages for low rotation of the shaft but it is doubtful if even this addition serves the purpose. So far, the reciprocating steam engine has the advantage at low speeds in all classes of ships.

A few examples of sister ships using different types of propelling machinery will serve to show the relative rotation speeds. Among these the most interesting are the three scout cruisers, Birmingham, Salem and Chester, fitted respectively with triple-expansion engines, Curtis turbines and Parsons turbines. The data in the small table are taken from the acceptance trials, as the results of the recent tests are not yet available for publication. The German cruisers are taken from a paper by Mr. Bauer:

Name of ship.	Type of engine.	Speed in knots.	Revolutions per minute.	Percentage slip of propeller.
1. Birmingham	Reciprocating	22.5	172.1	12.65
2. Birmingham	Reciprocating	24.33	191.7	15.8
3. Salem	Curtis turbine	22.5	312.5	16.17
4. Salem	Curtis turbine	25.95	378	20.28
5. Chester	Parsons turbine	22.5	473	18.46
6. Chester	Parsons turbine	26.52	614	25.56
7. German cruiser	Reciprocating	23	143	
8. German cruiser	Parsons turbine	23	528	
9. German cruiser	Reciprocating	24	187	
10. German cruiser	Curtis turbine	24	335	

The total indicated horsepower for all machinery, including auxiliaries, on the Salem was 10,836 at 22½ knots. This was obtained by adding 10 per cent to the shaft horsepower recorded by the torsion meter. On the Birmingham the power for all purposes was practically the same, being 11,098 at 22½ knots. The power on the Chester was not recorded owing to some defect in the measuring apparatus.

In the case of the first two German cruisers the shaft power of the Parsons turbine exceeded the indicated power of the reciprocating engines by 10 per cent while for the second two the reverse was true, the Curtis turbine requiring 11 per cent less power on the shaft than the indicated power of the reciprocating engine.

Comparisons of this kind are very unsatisfactory, however, as the relation between the indicated horsepower of the reciprocating engine and the effective power on the shaft depends upon too many facts to be well-known for any special case, except after extensive experiments for the purpose of ascertaining accurately the work lost in friction. Besides, it is very difficult to take account of the effect of different designs of screws upon the hull resistance. No two ships have exactly the same auxiliaries and no two crews ever work with precisely the same efficiency. Consequently no fair bases of comparison have yet been established and the results are likely to be inconclusive.

Little Advantage Between 20 and 25 Knots.

The only sound conclusion to be reached from the data at hand is that in the matter of power, weight and economy there is little to choose between the reciprocating engine and the turbine for speeds between 20 and 25 knots, with perhaps a preponderance in favor of the latter. Below 20 knots the results are largely in favor of the former. The Birmingham's engines will probably be found to gain over the other two in economy and ease of handling as the speed decreases. But this is not the whole question for a man-of-war. Her maximum speed may be required for only short intervals or in emergencies, but when it is needed it is needed badly; consequently, the machine which will maintain that speed reliably will invariably be chosen. There is another aspect of the case for battleships and armored cruisers and that is the vibration. A steam engine may be balanced for the reciprocating

[1]Late U. S. N. professor of mechanical engineering, Harvard University.

*Abstracted from *Engineering Magazine*.

weights, but it cannot be balanced against variations in the turning moment, and therefore any ship using it will be subject to vibrations against which the steam turbine is perfectly free. Another thing, the latter drives a smaller screw and the immersion can be made deep enough to lessen the throb of the propeller materially so that vibration from that cause may in large part be eliminated. The vibration is of small moment in a freight ship and it is not of primary importance even in a passenger ship; but it may become very serious in battleships if it interferes with sighting the guns while moving at high speed. On this issue the turbine should undoubtedly be selected for all heavily armed ships.

Limitations of the Turbine.

The types of ships for which the turbine is to be preferred to the reciprocating engine are war vessels and passenger ships of high speed, but it must be remembered that by far the greater part of the world's commerce is carried in freighters of very moderate or low speed. For these the reciprocating engine must be used until a more efficient turbine at low speeds can be designed, or a more efficient propeller at high speeds. The three-cylinder triple-expansion engine occupies this field admirably. The exact speed at which it should give place to the turbine has not yet been worked out for different classes of ships. The deciding factors are probably displacement and shape of hull, together with the arrangement and design of propellers.

The last word has not been spoken about either method of driving ships. It is possible that few more large reciprocating engines will be built for ships exceeding 20 knots in speed, and that few turbines will be used in freighters and other vessels with a speed of 15 knots or less. Between 15 and 20 knots the field is open to either.

Combination of Reciprocating Turbine Engine.

A compromise in the nature of a combination of the two, giving to the steam engine the high-pressure part and to the steam turbine the low-pressure part, may ultimately become the standard method of propulsion excepting for very high or very low speeds. This combination has been tried with very favorable results in several cases. It was first used in the Velox, a torpedo destroyer built for the Parsons Marine Steam Turbine Co., in 1903, and sold to the British admiralty. Two triple-expansion reciprocating engines of 150 horsepower are coupled to the central shafts carrying the low-pressure turbines. For cruising the steam enters the two steam engines and passes successively through the outside wing turbines and the central low-pressure turbines. For high power, the steam engines are uncoupled. When the low power of the reciprocating engines, 300 horsepower, is compared with the 10,000 developed by the turbines, the installation in the Velox becomes a very poor test of the combination.

A torpedo boat built by the Yarrow company in 1903 had a triple-expansion engine on the center shaft for cruising purposes and led the exhaust direct to the condenser. The engine was entirely independent of the turbines on the wing shafts, and was therefore not used in combination with them. These turbines were of the Rateau type and this boat made on trial 26.39 knots with the reciprocating engine at 576 revolutions per minute and the turbines at 1,300.

The first real test of the combination for marine service was in the Otaki, built in 1908, for the New Zealand Shipping Co. She is said to be about 10 per cent more economical than her sister ships, the Orari and Opawa, fitted with reciprocating engines. The best example of the combination is afforded by the White Star liner Laurentic, built for the British-Canadian service. The ship is 565 ft. long by 67 ft. beam and 14,500 gross tonnage. There are three screws. Each wing shaft is coupled to a four-cylinder triple-expansion engine of 7,800 horsepower and the center shaft is driven by a low-pressure turbine of 4,600 horsepower. There are two condensers used for the turbine, or for the exhaust of the wing engines when the turbine is not running. A large change valve in the exhaust nozzle of the steam engines enables the engineer to turn the exhaust quickly from the turbine to the condenser when reversing. The total horsepower is about 20,000 and the ship is to make 18 knots. The steam engines in this arrangement seem rather large for such a combination but the designer was probably influenced somewhat by the requirements for navigating the St. Lawrence river.

The types of ships to which this combination seems to be specially adapted are high-speed cruisers and battleships which usually cruise at low speed for the purpose of saving coal. Several possible arrangements and designs of machinery suggest themselves. Those adopted for the Laurentic would be satisfactory, but the proportion of power on the triple-expansion engines is too great. The best general design would probably be two three-cylinder compound engines on the wing shafts with a low-pressure turbine on the center shaft capable of taking half the load at full speed. For maximum power live steam might be turned into all the cylinders with the exhaust going to the turbine. For small speeds the wing engines could be used as compound with the exhaust going direct to the condenser, and the center screw uncoupled.

Transmission by Electricity.

A method of transmission by electricity has been suggested by a number of engineers as the best solution of the marine problem, and recently a paper by W. P. Durtnall before the British Institute of Marine Engineers has presented the case in concrete form. He proposes high-speed turbines to drive generators from which the current passes to motors on the main shafts. He would use polyphase alternating currents with synchronous generators and squirrel-cage induction motors for the purpose of keeping down weight and promoting efficiency of transmission at a number of speeds. One example worked out with a view to determining the actual weight of machinery for a 4,000-horsepower ship gave 20.5 pounds per shaft horsepower. This is heavier than for all-turbine propulsion, but inasmuch as there will be greater economy in the use of steam for all speeds the reduction of weight in the fire room will more than offset the increase in the engine room, and the total weight chargeable to propulsion will be less than that for all-turbine or all-steam-engine installations. The calculation is entirely theoretical and for that reason it is not convincing.

Other systems have been suggested; in fact, when the producer and gas engine are added to the list, the probable outcome of the keen competition for the field cannot be predicted. The whole subject of marine propulsion is in such a state of flux that anything may survive. It is possible that the steam engine may take a new lease of life for high-speed ships and come back to its own once more. While all sorts of schemes are put forward, one test should invariably be applied; that is, the probability of derangement or breakdown. That probability is increased more than in proportion to the number of links between the boiler and the propeller. It is just like multiplying a number of efficiencies together—the ultimate efficiency, as well as the ultimate reliability, is less than that of any single link. Consequently, the

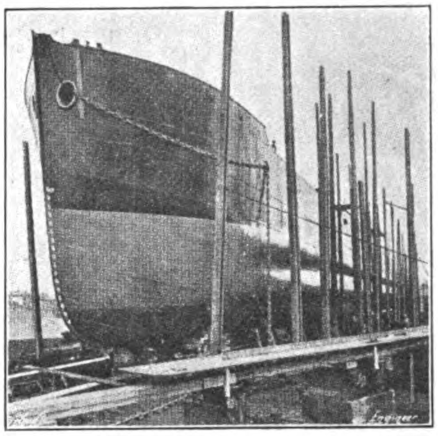
all-turbine or the all-steam-engine machine is to be preferred on board ship to any combination for effecting economy, unless the gain more than offsets the loss from probable repairs. One of the most useful devices for marine work would be a thoroughly reliable, noiseless gear of high enough efficiency to make it worth using with a very high-speed turbine. If it could be designed for variable speed as well as reversing, the steam turbine would soon replace the steam engine in all classes of ships.

An interesting example of the system proposed by Mr. Durtnall applied to a special case, is in actual use for the Chicago fireboats, Joseph Medill and Graeme Stewart, designed by W. I. Babcock. (See MARINE REVIEW, May, 1909.) There is a central station of two 660-horsepower Curtis turbines direct connected to two 220-kilowatt direct-current generators and two-stage centrifugal pumps. The current from the generators is conducted to variable-speed motors on the two propeller shafts. The motors can be controlled from the pilot house, as well as from the engine room, and the captain can easily direct the movement of his boat without signalling to the engineer. When the ship is going to a fire the power can be thrown on the generators and motors by letting the centrifugal pumps remain dry, and when lying still, the whole power of the turbines can be used in pumping water. The test of these ships gave very satisfactory results both for propulsion and pumping. The weight of machinery does not appear in the report. That was in this case not a controlling factor, and yet the total weight of machinery, boilers and pumps was doubtless taken into consideration.

CORRUGATED SYSTEM OF SHIP CONSTRUCTION.

THE MARINE REVIEW in its August issue made reference to the steamship Monitoria, which is being built at the ship yard of Osbourne, Graham & Co., Hoylton, Sunderland, for the Ericsson Shipping Co., Newcastle - on - Tyne. Further particulars are now obtainable from the *Engineer*, London.

This vessel is the first to be built from the designs of the Monitor Shipping Corporation, of Newcastle-on-Tyne, and her construction represents an interesting departure from ordinary practice. The Monitoria measures 279 ft. by 40 ft. 1½ in. normal extreme breadth, increased to 42 ft. by the application of the Monitor projection, and has a depth, moulded, of 20 ft. 7½ in. The vessel is of the single deck type, with poop, bridge and forecastle, and her deadweight capacity is about 3,300 tons. She will have large hatchways, five winches, steam windlass, steam steering gear, and large



S. S. MONITORIA ON THE STOCKS.

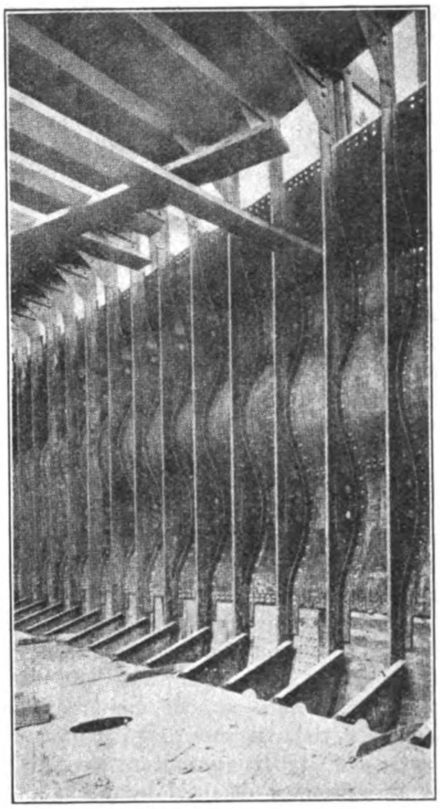
water ballast capacity, and will be fitted with triple-expansion engines built by the North-Eastern Marine Engineering Co., Ltd., Sunderland, with cylinders 21 in., 36 in., and 56 in. diameter, and 36 in. stroke.

The salient features of the Monitor system are well illustrated in the accompanying engravings, from which it will be seen that the shell plating is swelled out in two places at each side, between the light and the load lines, in the form of a somewhat flat arc, which is gradually curved into the flat side of the normal vessel above and below and also between these arcs. As a result of experimental work extending over some few years, it is claimed that with the Monitor system it will be possible to reduce the vertical amplitude of the waves, and to utilize the power thus saved. The crown of the Monitor corrugation is 11½ in. from the main frame, which latter is 8 in. by 3 in. The bulb angles are spaced 2 ft. 4 in. apart, and the corrugated frames are 3½ in. by 3 in. Plain angles are attached to each main frame and the corrugation gusset plate at each frame. There are no side stringers. It is affirmed that the projections will give additional buoyancy, and a considerable increase in the hogging and sagging strength, so that the stress on the material is reduced both at the keel and the gunwale.

As this application is in the nature of an addition to the ship rather than a drastic alteration to the main structural system, it will be applicable to all classes of steamships. As a matter of importance to owners who have vessels coming on to their No. 3 Surveys, it is stated that the alteration may be effected at very slight additional cost, and that it will increase the deadweight by 3 to 4 per cent, whilst the coal bill will be reduced by 12 to 15 per cent for the same speed as previously, or, if the coal consumption remains unaltered, the vessel with her extra deadweight will have a speed increase of about ¼ to ½ knot, according to her size and class. It is claimed that this system of ship construction will bring about a reduction in the weight of machinery necessary for a given speed, and will, therefore, permit of an increase of the deadweight amounting to (approximately) 3½ to 4½ per cent, and, with more economical engines, there will be a reduction in coal consumption for the same speed as obtained with a vessel of the ordinary form.

The trials of the Monitoria are thus given in *The Shipping World*:

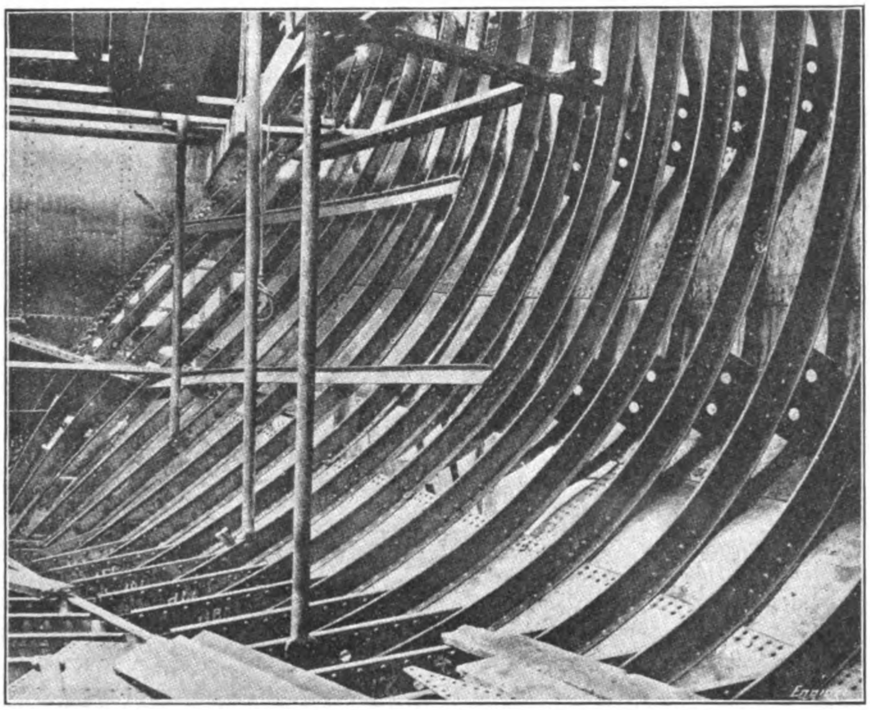
Some very interesting results were obtained at the loaded trial trip of the steamship Monitoria on Friday last. The Monitoria, which, it will be remembered, was built at Sunderland on the



INTERIOR VIEW SHOWING PLATING OF S. S. MONITORIA.

Monitor patent design, to the order of the Ericsson Shipping Co., Ltd., Newcastle, had her ordinary light trial trip on the Saturday previous. In the interim, she had loaded 3,300 tons of coal and bunkers, and was bound to

Stugsund with her cargo immediately on completing her loaded trials. These loaded trials were intended to compare with the results obtained of those recorded on the light trial and with the records of 23 vessels built by the same builders from the same model on ordinary lines. It should be noted that the loaded trials were conducted with the ordinary bunker coal which the ship was to use on her voyage, and with the ordinary staff of engineers and firemen. Actual working, and not merely show, results were therefore obtained. After a half-dozen runs over the Whitley measured mile at varying revolutions, a speed of 10¾ knots was obtained, or practically the same as on the light trial. This means that the ship loaded, with her corrugations submerged, steamed as fast as she did light when the corrugations were above the water line and not, therefore, operative. But this was not the only result obtained. A comparison with the speed curves of the other sister ships built on the ordinary lines without the grooved sides in every case showed an improvement, and an improvement also on the speed curves obtained by Mr. Haver in the experimental tank, and this improved speed was attained with 100 tons more cargo on board and 140 tons more displacement than any of the other ships. To sum up, therefore, Friday's loaded trials clearly demonstrated that the Monitoria could carry more cargo, attain a higher speed on a smaller coal consumption than any of her numerous sister ships built on the ordinary model, while the virtual disappearance of the bow wave, the remarkable steadiness of the ship, and the absence of vibration were very striking features which the whole company of visitors commented upon with gratification and even surprise. We should add that a representative of *The Shipping World* was on board during these trials and saw for himself how the ship behaved. The steadiness of the ship and her easy motion as she glided through the water were palpable to all. The comparisons as to speed and coal consumption and carrying power furnish valuable data which we anticipate will enable both builders and owners technically to demonstrate the virtues of the Monitor patent design, already vindicated in their eyes.



INTERIOR VIEW SHOWING PLATING OF S. S. MONITORIA.

S. S. KAROOLA.

On Thursday, July 8, the twin-screw passenger and cargo steamer Karoola, built by Messrs. Harland & Wolff, Ltd., to the order of Messrs. McIlwraith, McEacharn & Co., proprietary ltd., of London and Melbourne, left the builder's works at Belfast, and after adjustment of compasses and a satisfactory trial trip, proceeded to Glasgow, whence she will sail for Melbourne at the end of the month.

The new vessel, which is 436 ft. long, 56 ft. 3 in. beam, and about 7,500 tons, has been specially designed for the Australian trade, and the employment of steamers of this class round the coast of Australia. The Karoola, besides having accommodation for a large number of first, second and third class passengers, has also every facility for the rapid loading and discharge of cargo, for which the vessel has large capacity. The engines are of the builder's quadruple-expansion "balanced" type, and the ship is fitted throughout with electric light, fans, etc.

The passenger accommodation is of a superior type, the size and luxurious furnishings and decoration of the public rooms and staterooms being such as to insure the utmost comfort. The first-class dining saloon, situated on the main deck, is a handsome apartment, with parquetry floor, sidelights arranged in pairs, and the tables arranged on the popular restaurant style. The room is panelled and framed in oak, relieved with carving; the ceiling finished flat; and the furniture is oak.

The first class main staircase is in oak, the entrance being into the after part of the lounge.

The first class lounge on the bridge deck forward has silk panels, and is framed in Spanish mahogany, with furniture and dado of the same material. There is a handsome bookcase at the forward end, also piano, and the lounge is fitted with writing and card tables, and has a fine dome skylight overhead.

The first class smoke room, on the same deck, is arranged with bays, having writing and card tables. The room is in oak relieved with carving, and with skylight overhead.

The first class staterooms are nearly all arranged on the tandem system, making them practically all outside rooms. The upholstery is red moquette; carpet, Brussels; furniture, mahogany. There are two sets of suite rooms.

The second class saloon on the main deck is a spacious apartment, panelled and framed in white, relieved with gold; upholstery is tapestry; furniture and dado mahogany; the ceiling panelled and framed in white; the floor has carpet runners of red Brussels.

The second class lounge on the bridge deck is panelled and framed in sycamore, with furniture and dado of mahogany; upholstery, blue moquette; floor, inlaid linoleum tiles; the ceiling is panelled and framed in white. The room has a fine piano at the forward end, and bookcase at after end.

The second-class smokeroom is on the boat deck aft, panelled and framed in oak; ceiling, plain white, handsomely upholstered in green Morocco; floor laid with artistic tiles. The room has an arrangement of small bays and card tables.

All these public rooms, also the second class entrance on the bridge deck, are attractive and comfortable apartments.

The second class staterooms are also arranged on the tandem system. The floors of these rooms are covered with Brussels carpet; upholsery, blue moquette; furniture, mahogany.

The third class accommodation includes a dining saloon and a general room; both rooms panelled and framed in white, and with mahogany furniture. The third class staterooms are in keeping with the excellent character of this accommodation.

The arrangements for the comfort and enjoyment of passengers include horizontal and parallel bars and other gymnastic apparatus on the boat deck. These facilities for physical exercise at sea will doubtless be greatly appreciated.

The vessel is constructed on the cellular double bottom principle and divided into watertight compartments.

The steamer is fitted with Harland & Wolff's steam steering gear, which has long been recognized as providing an additional element of safety, and all the arrangements for working ship and cargo are of the latest type.

In addition to the general cargo arrangements and refrigerated space, the vessel is arranged for the carriage of cattle or horses forward on the main deck.

During construction the Karoola has been under the inspection of R. E. Thomson, the owner's superintending engineer, and the vessel on her trials was accompanied by Mr. McIlwraith, the senior partner of Messrs. McIlwraith, McEacharn & Co., and a numerous party of London and Australian friends, along with Mr. Andrews and Mr. Cuming, directors of Messrs. Harland & Wolff, Ltd.

The Advance of Marine Engineering in the Early Twentieth Century.[1]

By Arthur J. McGinnis.[2]

NEARLY 40 years have elapsed since this institution had the first "Review of Marine Engineering" read before it at the Liverpool meeting in 1872, and as it is not quite 10 years since the last Review was read, it becomes necessary to modify the title adopted by the able authors who in the past have so clearly brought forward the subject for consideration. Before proceeding, it may be well to explain the omission of drawings or diagrams in this paper as in the former, and for this the author can only plead that the exigencies of a busy life amongst the vicissitudes and happenings of Liverpool steam-shipping have left but little spare time; and further, the turbine and electric developments have been of late extensively illustrated in all engineering journals.

Before reviewing the doings of turbine machinery, the author would like to have it clearly understood that he is in no way, financially or otherwise, connected with the manufacture or development of such machinery, and that the statements and opinions expressed are entirely based on careful study and watching of the progress of the numerous vessels fitted. Under the circumstances, it is not out of place to note this review, as being that of a new century, owing to the coincidence that it practically relates the advance of entirely new departures from the well-known forms of reciprocating and piston engines, which hitherto were embraced under the simple name "Mechanical Engineering." This will be clearly demonstrated by the fact that, after consideration, it is found to be unnecessary in any way to touch upon the numerous intricacies and doings of reciprocating machinery, but at once to proceed to the consideration of the new form of marine engineering, which so far as the merchant service is concerned commenced with the twentieth century.

True it is that the first turbine-driven craft appeared in 1894, and, after various developments, it in 1896, under the name of "Turbinia," attracted marked attention, and obtained for the persistent and now famous inventor (Hon. C. A. Parsons) public recognition of his long years of uphill work and experimenting. Some idea of how long this system of obtaining a simple form of rotary machinery has been occupying attention may be formed, when it is borne in mind that almost the first actual Parsons turbine machinery publicly exhibited was at Shipperies Exhibition, held in Liverpool in 1886, when an installation was placed there to generate electricity.

From that time onward, turbine-driven electric generating plants have been gradually introduced in electric generating installations, both land and sea, but more especially on steamers where the space is so restricted. Notwithstanding the excellent performance of the "Turbinia" in 1896, it was not until 1900 that the first order for a real test of this form of propulsion for a commercial venture was placed. This was given by a syndicate headed by Capt. Williamson, owner of one of the Clyde river services, and in June, 1901, the King Edward commenced plying; it was so successful that it was followed soon afterwards by the Queen Alexandra, in 1902. Since then a rapid adoption of the system has taken place, turbine steamers having practically superseded all others for rapid channel services, and also for ocean-going passenger vessels of considerable speed, the first Atlantic liner fitted being the Allan Victorian, in 1904, followed in 1905 by the Cunard liner Carmania, and the same company's Lusitania and Mauretania in 1907.

By permission of James McKechnie, Table I of his paper, read before the institution at Barrow, in 1901, brought up to date so far as turbine machinery is concerned, is reproduced, and it will be seen from this that practically no advance or improvement has been made in consumption of fuel since that date, but the adoption of turbine machinery, although not actually improving upon the consumption per indicated horsepower, has brought about an advance, by the fact that it has enabled greater speed to be obtained.

Up to the present time but little progress has been made in the adoption of turbines for slow-going merchant or other vessels, owing, no doubt, to the difficulty of applying the turbine to the single propeller, but in no other field of operation is there such an opening for a simple form of rotary machinery.

To those who have of late had the experience of visiting the engine-rooms of vessels where nothing is visible but large cylindrical-looking, unmoving

[1]Paper read before the Institution of Mechanical Engineers of the United Kingdom, July 29, 1909.
[2]Liverpool, England.

masses of metal, instead of towering cylinders and columns inside of and about which piston and connecting rods, crossheads, valve motions, crank-shafts, levers, etc., are flying to and fro, it is self-evident that the old style must give way to the new. When it is borne in mind that it has taken over 70 years to render all parts of the reciprocating marine machinery fit for the work, it cannot be gainsaid but that in a few years the difficulties yet to be experienced will be surmounted by the adoption of the turbine in the cargo steamer.

Table I.

Boilers, Engines and Coal.		Average Results.			
Year	1872	1881	1891	1901	1909[1]
Boiler pressure lb. per sq. in.	52.4	77.4	158.5	197	195
Heating surface per sq. ft. of grate sq. ft.	....	30.4	31	38 & 43*	as 1901
Heating surface per I. H. P., sq. ft.	4 41	3.917	3.275	3.0	as 1901
Coal per sq. ft. of grate, lb.	....	13.8	15	18 & 28*	as 1901
Revolutions per minute, revs.	55.67	59.76	63.75	87	....
Piston speed, ft. per min.	376	467	529	654	None
Coal per I. H. P. per hour, lb.	2.11	1.83	1.52	1.48	as 1901
Average consumption on prolonged sea voyage, lb.	....	2	1.75	1.55	....

*Natural and forced draught respectively.
[1] Turbines.

Turbine Machinery for Cargo Vessels.

In order to make some efforts to bring about the use of the steam-turbine or other form of rotary machinery in this type of vessel, it will not be out of place here to consider the nature of the problem which awaits solution. In full-lined vessels of the single-screw "tramp" type, the speed of revolutions of the propeller is not so great as to allow of the propeller-shaft being driven direct from the turbine-rotor, so that it seems as if even for this class of vessels it would be necessary (notwithstanding the increased first cost) to adopt twin or even triple screws. In view of the present depressed state of shipping, this seems rather a startling proposition, but as for all practical purposes it is better to have more than one propeller on any vessel, there is no reason why, if a better type of propelling power can be obtained, this should not be done in the same way as the departure was made from the two to three, four and five-crank engines in all classes of merchant vessels.

It may be remembered that when these multiple cranks were first adopted, it was generally remarked by those who knew that multiple cranks were all very well for high-speed mail boats, that three-crank engines would not suit the cargo tramp; whereas, today they are fitted in all sorts, from trawlers, drifters, etc., and even five-crank engines are now found on cargo boats and six cranks on express liners. Bearing this in mind, there does not seem to be an insuperable objection to apply the turbine to slow-speed vessels by the adoption of multiple propellers, say three, as on moderate-speed liners. These propellers, smaller in diameter than the present single or twin screws, running at such speed of revolution as would allow of direct connection to the Parsons turbine, could, in the author's opinion, be applied, and at but little if any more first cost than in existing practice; for although the cost of three lines of shafting is to be met, they would be much smaller and lighter, and the advantage of the boiler pressure being much lower would enable considerable saving of cost and weight to be gained.

The marked advantages of turbine machinery in all the numerous vessels fitted up to date is so evident that it will be worth while enumerating them here, in order to point out the desirability of an early effort being made to apply them to the class of vessel now under consideration:—

(*a*) The rapid changes of motion (twice per revolution) being done away with, the risk and liability due to fractures or flaws caused by concussions and shocks is altogether eliminated.

(*b*) The absence of piston-rods, glands, slide valves, guides, crossheads, connecting rods, link motion and crank shafts removes all risk of undue heating and distortion of parts.

(*c*) The steady revolving motion of the shafting reduces the risk of breakage of shafts and propeller-blades to a minimum, and also allows of less supervision, so that the men in charge can devote more time to the firing and working of boilers, etc.

(*d*) The avoidance of risk of serious breakdowns caused by racing in heavy seas.

(*e*) The marked economy brought about by the very great reduction in the use of consumable and other stores, such as oil, packing, etc.

(*f*) The saving in men's time in opening and adjusting and general overhauling.

(*g*) The avoidance of an extensive outfit of tools and gear necessary to effect the work.

(*h*) The reduction in first cost of many spare parts which must be carried for piston machinery in case of a breakdown.

(*i*) The lowering of boiler pressure which has allowed of an extensive reduction in weight and first cost.

(*j*) Aother advantage is that the past eight years have shown that the Parsons turbine machinery will not break down or stop. From extensive inquiries which the author has made, notwithstanding that there are now over 70 steamers continuously plying to and fro, no sailing schedules have been upset by a failure of machinery up to the present, nor has a turbine steamer ever had to be towed into port.

On the other hand, beyond the difficulty of keeping down the speed of propeller revolutions to suit the turbine, the objections against its adoption are not very serious; apparently some cargo space will be absorbed by having two or three tunnels aft, but this can be partly compensated for by a considerable reduction of engine-room opening through the decks upward. The risk of breakage of propeller blades will, no doubt, be put forward; but this all recent experience has shown in reality is no greater than with the single propeller.

By consideration of the foregoing facts, it will be seen that the only (but naturally the most important) feature, which has so far been against the use of turbines for cargo boats, is the mechanical one of relative speed of turbine-rotor and propeller, and it is much to be desired that some similar syndicate to that which initiated the start on the Clyde boats be formed to make a start with a cargo boat, say, of 2,000 to 3,000 tons deadweight, and 10 knots speed. It also is necessary for those now actually engaged in the manufacture of turbine machinery to give the matter the most careful investigation, for the author, speaking with considerable knowledge and experience of reciprocating or piston machinery, has no hesitation in stating that rotary machinery must eventually replace the present system.

Considering that under the British flag there are more than 6,000 steamers of the cargo type, it will be readily conceded that this is an immense opening for the mechanical engineers of the country to supply new machinery for even the existing steamers. If this be the case—and the author is strongly of opinion it is—there will be a revival of re-engining vessels, such as was experienced in the early seventies in the replacing of simple by compound machinery, with the difference that it will not be necessary to re-boiler.

In order to show how rapidly turbine machinery has come to the front, Figs. 1 and 2 have been compiled, and from these it can be seen that the adoption of turbine machinery for marine propulsion has been extremely

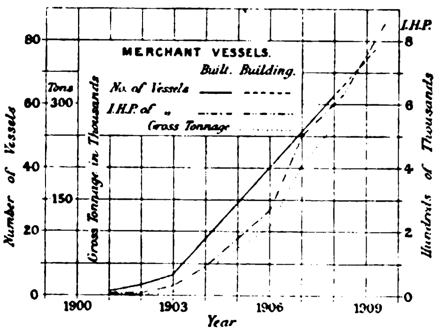


FIG. 1.

rapid, rising in the merchant service from one steamer and 3,500 horsepower in 1901 to 64 steamers and 603,200 horsepower in December, 1908. There is no doubt that the adoption will become increasingly rapid in the future, as the system spreads amongst all classes of steamers.

Combined Piston and Turbine Machinery.

An instance of the striving after improvements on the machinery of

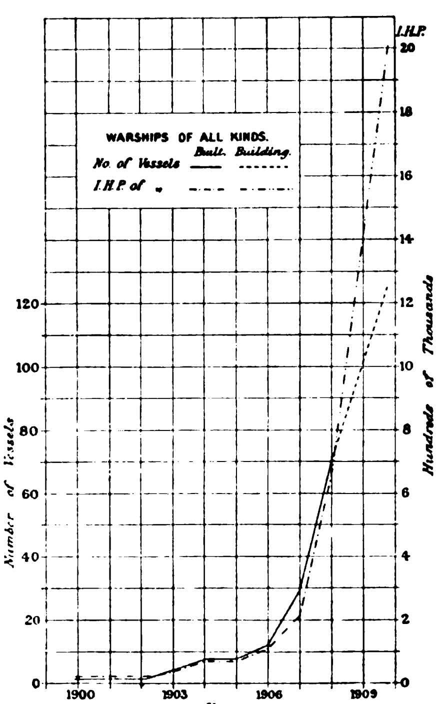


FIG. 2.

steam vessels is illustrated by Fig. 3, which is an outline arrangement of the combined system of piston and turbine engines recently built by Messrs. Denny, of Dumbarton, for the direct New Zealand service. This was fitted on the steamship Otaki, of the New Zealand Shipping Co., London. The adoption of this combination has been brought about by the efficiency of the turbine system when working on the vacuum, as the terminal pressure in the low-pressure cylinder of either triple or quadruple machinery is as a rule so high that it has been found that there is power enough remaining to drive another or third propeller before allowing the exhaust steam to reach the condenser.

The opportunity of being able to ascertain what superiority may be in this arrangement over that of ordinary piston engines was taken advantage of by Messrs. Denny, who built one steamer named the Orari for the New Zealand Shipping Co., and on a second one being required they induced the owners to adopt the turbine combined system in the second boat, both vessels having the same boiler power, and being built off the same lines. The result of the trial trip, which took place in October, 1908, showed a slight increase in speed of about half a knot over that of the Orari, and so far as can be ascertained this advantage has been maintained in the regular trade. As these twin vessels are like the Caronia and Carmania, and also the Laurentic and Megantic, of special interest for comparative purposes, it may be of some service to note their particulars in Table II.

So far as these combined piston and turbine-engined vessels have been at work, satisfactory results have been obtained; but it is evident that an extensive adoption of this system will not be made, the days of the steam piston-engine for marine propulsion being numbered.

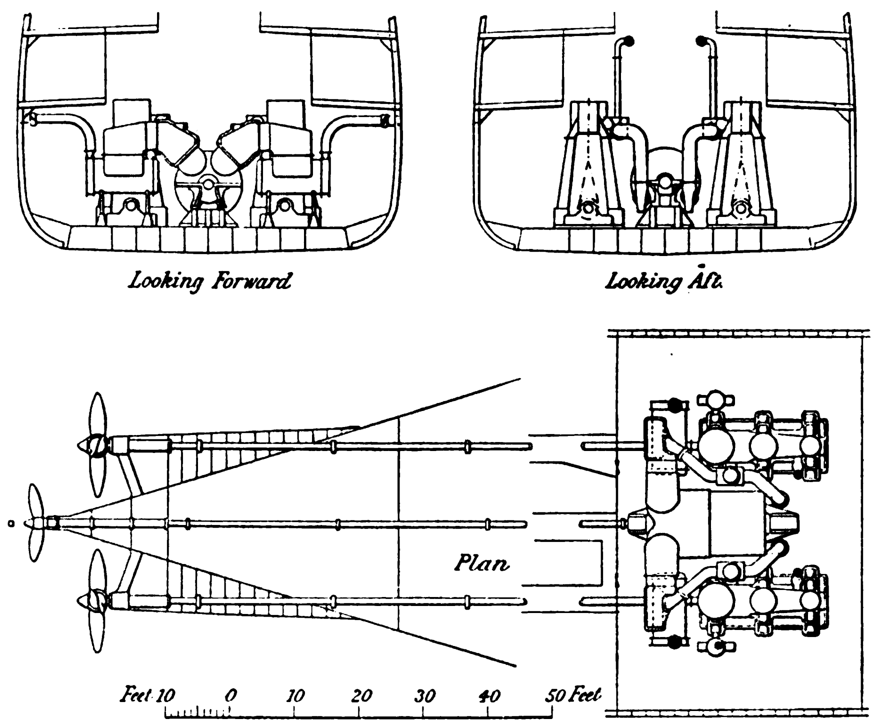


FIG. 3.

Coming now to the mechanical details of turbine propulsion, it must be noted how few there are to discuss compared with the very numerous details of piston engines, almost each one of which in itself has been the foundation of elaborate papers and discussion in the past. The only detail in the Parsons turbine-machine since the shape and formation of the blades in both the stator and rotor have been fixed by its inventor, is the fastening of the blades or vanes, and this is of such a simple nature that all difficulties have been surmounted, and so far as the turbine proper is concerned the wear and tear are trifling. No doubt in some cases trouble has been experienced in straining in the rotors, due to centrifugal action, and it has been found that rapid corrosion in certain parts has taken place, but a few years' further experience will probably solve and effectually remedy these and some other minor defects which have occurred. It is a pleasing duty to note how few are the details or defects now requiring attention in the turbines themselves, but it must not be forgotten that in the first trials many difficulties were experienced, and special merit is due to those engaged in the early developing of this machinery, led by Mr. Parsons, for so ably and so practically overcom-

ing the difficulties which presented themselves.

Condensers.

The obtaining of as perfect a vacuum as possible being a special factor in steam rotary engines, the question of an efficient condenser becomes all important, and it is remarkable that almost simultaneously with the coming forth of the turbine the first real efforts were made to improve upon the ordinary surface condenser existing since the days of Hall, who introduced it in 1831, and actually had it fitted on the paddle steamer Sirius, in 1837, and on the early Atlantic liner British Queen, in 1839. After considerable study and experimenting of the condenser problem, it is a matter of common knowledge that it is only a few years ago that this question was given the great consideration which so important a matter deserved. After considerable study and trials, most interesting results were obtained by D. B. Morison, who, acting in conjunction with Prof. Weighton, succeeded in discovering hidden defects and placing the designs of condensers, contraflo and others, on a satisfactory footing, and fully explained them in various papers read before kindred institutions. These improved condensers, with the addition of the modern improved air pumps and the vacuum augmentor of Mr. Parsons, have insured satisfactory working and have helped to hasten the adoption of the turbine.

Table II.

Year.	Steamer.	Length.	Breadth.	Depth.	Diam. of Cylinders. H. P.	I. P.	M. P.	L. P.	Stroke.	Diam. of turbine.	Boiler pressure.	No. of propellers.
1908	Otaki	465.4	60.3	31.3	24½	..	39	48	..	39	200	3
1906	Orari	460.7	60.2	31.3	2 of 24½	..	2 of 41½	2 of 69	48	none	200	2
1905	Carmania	650.4	72.2	40.0		Turbine			..	....	195	3
1905	Caronia	650	72.2	40.2	39	54½	77	110	66	none	210	2
1909	Laurentic	550	67.3	32.9	2 of 30	2 of 46	..	4 of 53	54	none	..	3
1909	Megantic	350	67.3	32.9	2 of 29	2 of 42	2 of 61	2 of 87	60	none	..	2

Shafting.

Owing to the adoption of balanced-piston engines and the turbine principle, the shafting of modern vessels has now almost ceased to be the source of anxiety and trouble known in the past, the shocks and uneven straining being almost altogether eliminated, so that it is unnecessary to comment upon this section of marine machinery, with the exception perhaps of the after-length of which the propeller is directly placed. This shaft, which formerly gave such trouble by frequent fractures, and even when no fracture took place, caused unnecessary expense by the frequent drawing of the shaft inboard for examination, has of late become more satisfactory by the adoption of long continuous gun-metal liners or casings. The latter prevent all corrosive action in the portion of the shaft not visible, and the revised rules for diameter have also insured ample strength being given to withstand the rough usage to which this part of screw-propelling machinery is so liable, owing to variation of draught of vessel and the violent racing and straining in heavy weather.

Propeller.

With regard to the propeller itself little can be said, as the design and style of construction have now settled down to recognized types for the various classes of vessels. Notwithstanding the numerous papers read on the subject and immense sheets of formulae and diagrammatic exposition given it, it is yet only by trial and result that the best propeller can be found for each vessel, and the recent alterations made in the blades of the two great liners Lusitania and Mauretania, serve to recall the doings of his majesty's steamships Iris and Mercury, in 1878-9, when still more startling and unexpected results were obtained.

Boilers.

Coming now to the steam generator, and looking back since the last time marine engineering was brought before the institution, in 1901, by Mr. McKechnie, it is not possible to note any advance or change in the design, as no marked alteration has taken place; but the improvements in the manufacture and working of larger boiler plates have resulted in the still further reduction of riveted parts. As an instance of how extensive the modern boiler shell-plate has become it may be mentioned that the largest plate yet rolled measures 42 ft. by 9 ft. 6 in. by 1½ in. thick and weighs close on 11 tons. Strange to say this plate is not fitted on one of the most powerful liners, but on a moderate-size Mersey tugboat named the Knight Errant. The introduction of automatic circulators, fitted inside the boilers without any working parts whatever, has materially reduced the repairs rendered necessary by the abnormal strains set up by the varying temperatures prevailing in different parts of the boiler.

In considering this question of boilers, one must not omit to call attention to the still further advantage to be gained by the adoption of turbine machinery, owing to the fact that lower steam pressure is required. What this means in saving of weight over the scantlings necessary for the boilers of quadruple and the later triple-expansion piston machinery can be fully realized, when it is considered that in the case of the Lusitania and Mauretania the saving in weight on the boilers alone is about 120 tons over and above that which would have been required if triple or quadruple piston engines had been used. This also applies in the case of the cross-channel vessels, such a the Isle of Man steamer Ben-my-Chree, to be seen at the Liverpool landing stage, the scantlings in this vessel being something like 75 tons less weight than would be required for piston machinery of equal power. To the naval architect this gain of weight presents a pleasing factor, enabling him to provide further luxury or want demanded by the exigencies of modern travel.

Mechanical Stoking.

A detail of considerable importance to the boiler room is that of the adoption of mechanical stoking of some description. This, like other subjects, has been the cause of numerous experiments and patents, but so far it cannot be said to be so satisfactorily solved as to insure universal adoption, although the Henderson system has been largely used. The fairly wide adoption of forced draught has, however, increased the difficulty, and this is much to be regretted, for there is no doubt that the want of some system is badly felt which could modify or completely do away with the arduous requirements of the stokehole of all steamers, at present so trying, and one may say so debasing, to humanity. When one conjures up the scene on board of a large liner where upwards of 1,000 tons of coal are consumed in 24 hours, every ton of which has to be manipulated by the firemen and trimmers in temperatures rising sometimes up to 120 deg. Fahr., the great want of mechanical contrivances is fully realized, and it is

to be hoped that suitable forms of mechanical trimming and stoking of coal may be brought about, or that the adoption of other fuels or system of propelling machinery may become prevalent.

Water Tube Boilers.

Before passing from the important subject of marine boilers, it would not be fitting to omit some allusion to the water-tube boiler. Notwithstanding the numerous designs which have been put to work on warships, torpedo craft, and in some cases merchant vessels, it must be admitted that up to the present this class of boiler has not succeeded, be the reasons what they may. In the warships of all nations, circumstances seem to have forced the adoption of the designs, but that it is unwillingly done is evident from the fact that for the various craft associated with royal navies outside the fighting line, the Scotch or tank form of boiler is generally adopted, as also in all royal yachts and other pleasure craft.

So far as the mercantile marine of the world is concerned, there are no more than 250 vessels of all classes of 300 tons and upwards fitted with water-tube boilers, and of these about 50 are passenger and the remainder of the ordinary cargo type. The most recent vessel fitted with water-tube boilers and the first with turbine machinery built in Japan is the Japanese steamship Sakura Maru, which is of the following dimensions:—Length, 335 ft. by 43 ft. by 31.6 ft., of 3,200 tons, and a displacement of 3,880 tons on 17 ft. draught, and 8,500 indicated horsepower, with speed of 21 knots per hour; being of the so-called Volunteer fleet, it is not unlikely that the adoption of the water-tube boiler Miyabara design has in this case been due to the naval requirements more than to its general suitability for commercial purposes.

Fuel.

Coming now to the important question of the nature of the fuel used, even here it is to be regretted that no great advance has been made; true it is that in certain trades and on steamers favorably situated to obtain oil-fuel progress has been made, but up to the present there is no pronounced sign that liquid fuel will generally supersede coal.

Internal Combustion Engines.

Following upon the subject of liquid fuel, there naturally comes the question of internal-combustion engines, which are now being widely adopted for smaller craft and also for barges. Numerous designs for different kinds of fuel are now being put to work, and are gradually being made use of in all parts of the globe, but up to the present no ordinary cargo vessel of 1,000 tons or upwards has been so fitted, but, like other branches of marine engineering, the striving after greater economy will no doubt bring further developments.

Following upon the liquid fuel internal-combustion engine comes the very important one of using gas generated on board the vessel: of this it is difficult yet to express a decided opinion, as, with the exception of the now well-known suction-gas vessel Rattler, but little experience has been gained and that only on smaller craft; at the same time consideration of the subject tends to raise hopes that a gradual introduction of the system may soon come about.

That a considerable number of wants for this class of machinery have yet to be surmounted cannot be denied; the want of simple and reliable reversing of propeller, ready provision for working all the numerous auxiliaries, providing heating apparaus and simple working appliances for cargo and such like, present great but not insuperable difficulties.

One feature connected with all descriptions of internal-combustion engines, which will no doubt to a certain extent militate against them, is that up to the present for marine and practically all other purposes they must be of the piston and reciprocating type, which leaves them open to the objection that they are commencing where the modern marine steam engine is leaving off. That is to say, the success of the steam-turbine machinery on board ship (as already considered) has practically created an objection to the further use of the crank-shaft and all its accompanying parts, so that under present outlook the rotary form of power motion appears to have the most favorable chance of general adoption, and it is to be regretted that, so far as can be seen at present, there is but little hope that direct rotary power can be obtained by explosive motors in the near future.

Direct Electric Drive for Propeller.

The fact that the coming power for marine propulsion must be directly rotary, coupled with the success of the steam turbine, has brought forward another system, which, in the author's opinion, will soon be widely adopted, namely, the application of electric power direct to the propeller shafts. In view of the fact that up to date steam still remains the most simple and most useful source of power available on board ship, and can, thanks to turbine machinery, be readily and economically put to generate electricity up to great power, it will not be out of place to note the advantages likely to accrue from the adoption of direct electrical shaft drive.

In the first instance, reversal of the propeller with full effective power is attained and readily effected. Secondly, the design of both the steam and electric plant can be so modified as to enable the naval architect to make better and more profitable arrangements for both passenger and cargo space.

The application of the electric drive and form of motor have now been so improved as to reduce wear and tear to a minimum, and has also increased the efficiency, so that prompt and reliable starting, reversing and stopping are insured. Owing to the fact that the lower boiler pressure can be used by the steam-turbine generator, it is anticipated that the weights of the steam and electric plants together will not exceed that of the present system of reciprocating machinery, and it is also estimated that the first cost will average about the same. Of the advantages of this system one which will commend itself to the navigating department is that the long-looked-for apparatus to control the movements of the propellers direct from the bridge may be obtained.

Another advantage is, that electricity like steam is capable of being readily applied to all the other requirements of shipboard, such as steering, windlass, and winch-work, combined with the further advantages of more economical distribution and giving a simple and agreeable artificial light throughout the vessel. It will no doubt be advanced by some, that if turbine machinery has been the great success claimed for it in the early part of this paper, why is it necessary to add further complications by introducing electrical drive? To this may be replied, that it is not proposed to use electric drive on fast vessels (naval or mercantile) where the turbine has been so successful, but to apply it to the slower-going cargo tramps, as if the promises now put forward are carried out—and electricians state that they are quite within the range of present practice—it will present the most simple means of obtaining rotary motion slow enough in speed to apply to the ordinary screw-

propeller working at from 70 to 120 revolutions.

For an account of the proposals as put forward, a study of the papers on electric power for main marine propulsion, brought before the Institution of Engineers and Shipbuilders in Scotland by Mr. Mavor, and later before the Institute of Marine Engineers, London, by Mr. Durtnall, will be found interesting. Should this system of main electric drive for working screw-propellers direct come about, it may be safely said that a new era of electric navigation is about to dawn, and one promising great results. For instance, the continued decrease in the boiler-pressures as commenced with the steam-turbine machinery will no doubt be further continued, and even lower pressures than now exist will be made use of, which will largely decrease the weight of boiler installations and so cheapen the first cost. Through the fact of the greater portion of the machinery being electrical other than mechanical, the heavy weights of such moving parts as pistons, piston- and connecting-rods, slide-valves, link motion, eccentrics, etc., will be done away with, and so render the outfit and overhauling of the electric boat (a vessel propelled by electricity generated on board by steam) more simple and more easily effected than on the steam-propelled craft at present in use.

Looking back to the papers previously read on this subject, it will be seen that no such remarkable changes have taken place since the introduction of steam navigation as during the few years which have passed since the commencement of the present century. In none of the previous papers has even an allusion been made to the likely use of the internal-combustion engine or the suction-gas for marine propulsion, and only in the last paper read by Mr. McKechnie in 1901 was mention made of the Parsons turbine, which is the first successful adoption of rotary instead of reciprocating or piston machinery.

Coming finally to the results attained by marine engineering to date, they may be summarized as follows: Vessels of close upon 800 ft. length and over 38,000 tons displacement are being propelled across the Atlantic at an average speed of 25½ knots, by turbine machinery working up to about 70,000 H. P., having a consumption of upwards of 1,000 tons per day. Similar results have been given in the turbine-propelled warship "Indomitable" of over 40,000 I. H. P., and maintained across the Atlantic with water tube boilers.

So far as the merchant marine is concerned, there is at present no sign that the great horsepower of the "Lusitania" and "Mauretania" will be exceeded or even equalled for some years to come, as the large vessels now under construction for the White Star Line, following the types of the vessels constructed by them during the past 20 years, are reported to have but a moderate speed of about 20 knots, so that the machinery installations will be only of very moderate dimensions and power. This latter course is also being followed by the continental lines, all their more recent vessels not exceeding 18 knots.

SIR JOHN THORNYCROFT'S SKIMMER, MIRANDA III.

This unique vessel is a mahogany boat, 22 ft. long, which under normal conditions seems to be a river launch, but is adapted for skimming on the surface when propelled at high speed. This boat, while normally seven knots speed, can attain a speed of 27 knots in smooth water, the increase in power being enormously less than is usually the case, even for suitably-designed hulls immersed under ordinary conditions. Her beam is 6 ft. 10 in. and depth 2 ft. 9 in. The bottom of the boat is shaped like a flat fish; the upper part is a whaleback. Under the keel forward a vertical fin plate is fitted, having a horizontal plane fitted at right angles to the fin. When going ahead as the boat increases in speed, the stern droops and the bow rises. At about 20 miles an hour, the horizontal plane reaches the surface of the water, and the boat skims, or glides, being supported only by the plane and the stern, which is of peculiar form to meet this condition, the whole of the keel being quite above the water. A little spray is thrown up, but hardly any wave or wash is created. When the boat is utilized as an ordinary launch, traveling in submerged state, the speed is seven to eight knots, with the motor making about 500 revolutions, but when these are increased to 1,450 revolutions, the vessel darts forward into the skimming position, and the speed is accelerated at a greater rate until from 23 to 27 knots is attained. The boat is steady at high speeds, but a quick see-saw motion is noticeable in choppy water, doubtless owing to the extraordinary position the center of gravity must be in. The speed obtained from such a short, broad hull, is simply marvelous and could not be obtained from a normal type of vessel. The engine is of the Thornycroft motor car type, fitted amidships with slight modifications to suit marine practice. Thus the valves are on the top, and the pumps at the forward end, so as to be thoroughly accessible. There are four cylinders of 4-in. bore. The engine drives a three-bladed propeller 16½ in. in diameter, the engine and shaft being set at an angle so that the propeller is at a considerable distance below, as well as projecting beyond the stern post. On trial, with a weight corresponding to one ton displacement, this boat averaged 27 knots during six runs over a measured course in fairly smooth water, the power of the machinery being estimated at 58 B. H. P., whereas in normal trim the speed is but seven or eight knots. It will be seen that a great increase in speed is got when skimming for a relatively small increase in power.

SIR JOHN THORNYCROFT'S SKIMMER MIRANDA III.

Westinghouse Propeller Testing Apparatus.

FOR the purpose of carrying out a series of tests of propellers in connection with certain turbine experiments, George Westinghouse, Pittsburg, has constructed the apparatus illustrated herewith.

The circular tank of reinforced concrete shown in Fig. 1 has fitted to it a long sleeve, similar in general to the ordinary stern tube of a ship and projecting some distance into the tank, and at such an angle as to closely simulate the actual working conditions existing between the propeller and the skin of the actual ship. The action of the propeller sets up a current movement in the tank, the velocity of which is measured by a set of paddles mounted on a vertical shaft and carried around with the water. This velocity is dependent on the propeller and the skin friction of the tank, and may be varied within limits by the proportioning of the propeller, and thus the actual working conditions may be closely approximated. The position of the propeller in the tank may also be varied, and thus the current or feed flowing to it may be constrained to a path nearly exactly parallel to the propeller axis, or at a more obtuse or more acute angle, still further approaching the working conditions of the ship.

Mr. Westinghouse, who has very generously furnished THE MARINE REVIEW with the photographs and drawings from which the illustrations were made, adds the following:

"In the arrangement illustrated the propeller is driven by a turbine having two casings—an inner and an outer one. The inner casing is carried by an overhung journal, as best seen in Fig. 2. This journal is hollow, and the steam supply is admitted through it, leakage being prevented by spring ring packings of the usual type. The nozzles (Fig. 2) are formed in the overhung casing and the reacting of the steam from them produce a torque, tending to rotate the casing in ball bearings, and this torque is exactly equal to the opposite torque exerted on the turbine wheel. It is measured by connecting the overhung casing to a platform scale at the side, as indicated in the illustrations. The outer casing is fixed, and simply collects the steam and delivers it to the exhaust pipe.

"The thrust on the propeller is measured by means of an hydraulic thrust block, best seen in Fig. 2. This consists of a couple of discs keyed to the shaft, and having between them a collar fixed to the casing, a second fixed collar being provided behind the second disc. Two oil-pipes supply oil under pressure to the interspace between the fixed collars and the discs on the shafting, keeping the two from coming into contact with each other, but transmitting the end thrust from the moving shaft to the fixed casing. An overflow conveys away the spent oil, fresh supplies being simultaneously forced in by a suitable pump. The thrust transmitted to the casing is transferred to the platform of a scale by the bell-crank lever shown.

"To permit of the free, though limited, axial movement of the propeller-shaft, which is necessary if the thrust is to be accurately recorded, the shaft is connected to the turbine shaft by a flexible coupling, the construction of which is best seen in Fig. 2. This

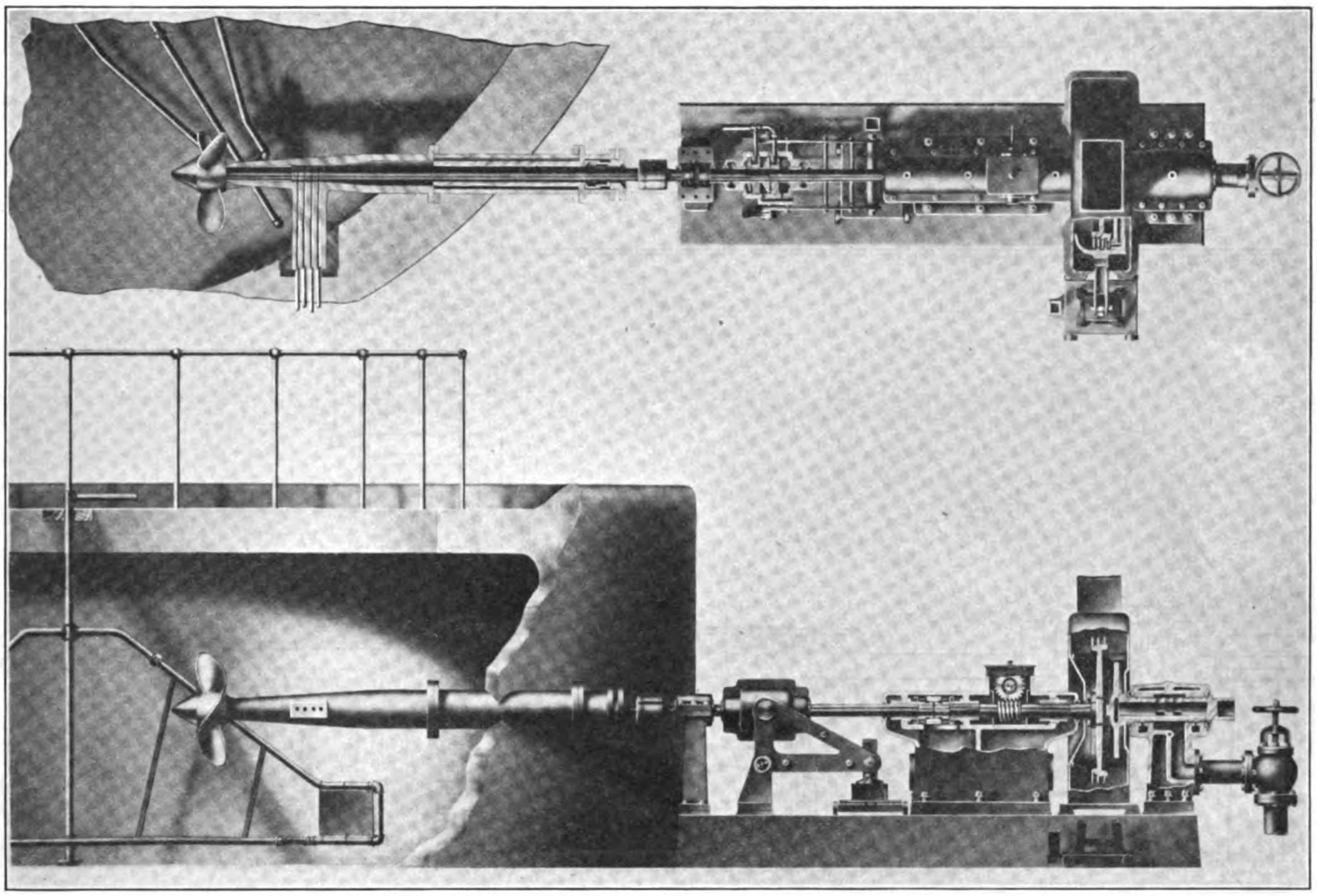


FIG. 1—GENERAL ARRANGEMENT OF WESTINGHOUSE PROPELLER TESTING APPARATUS.

transmits the torque, but communicates no longitudinal thrust to the turbine, as the engaging lugs of the coupling do not come into direct contact, but have ball races inserted between them to permit free longitudinal motion. The worm-drive shown beyond this actuates a counter registering the revolutions of the propeller.

"Referring back to Fig. 1, a series of pipes are shown leading away from the propeller-shaft sleeve through the casing of the tank. These serve to measure the water pressure on the propeller blade or boss, at any point desired by connecting them up to holes appropriately drilled for the purpose. Some very interesting results have already been obtained, as to the distribution of the water pressure over the blades and boss. Thus it has been found that along the whole of the middle line of the driving face of the propeller blade a negative pressure is indicated. In other experiments an exploring tube, fulfilling the function of a pilot gage, was fixed at different points in the wake of the propel'er, but quite close to the latter. This gage showed that near the tips the discharge from the propeller was as it is ordinarily assumed to be, but with certain models experimented with, a negative flow was indicated in the neighborhood of the boss. In this region the blades were apparently acting much as if they were portions of the impeller of a centrifugal pump, drawing in water near the axis, and discharging it further out. Again, with a propeller 12 in. in diameter, having wide-ended blades, the efficiency was diminished by 50 per cent on reducing the diameter to 10 in., thus affording further evidence that the inner portion of the propeller was doing little or no useful work. In some other experiments a better efficiency at high speeds was attained with a model of finer pitch with greater area than the standard type generally adopted for turbine vessels.

"The tank in which these experiments were made was 24 ft. in diameter. The speed of the propeller tips reached 12,000 ft. per minute, and in some of the trials as much as 400 horsepower were absorbed. A tank 50 ft. in diameter would suffice for the testing of propellers up to 4 ft. or 5 ft. diameter."

We hope for the further courtesy of Mr. Westinghouse in the results of tests carried out with this apparatus.

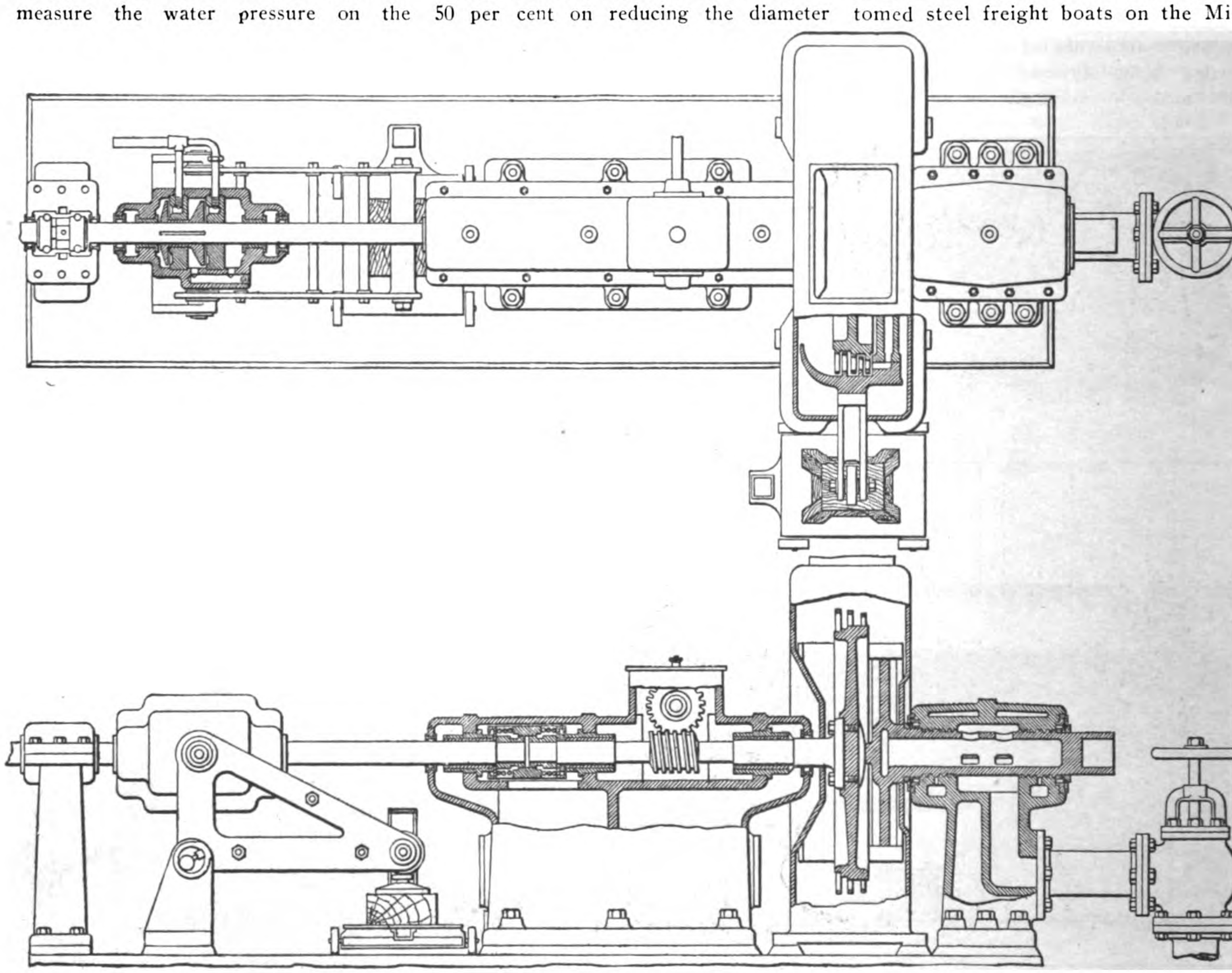


FIG. 2—PLAN OF APPARATUS, ARRANGEMENT OF MOTOR AND THRUST-WEIGHING DEVICE.

NEW MISSISSIPPI NAVIGATION CO.

It has been announced that the necessary preliminaries toward the organization of a $5,000,000 corporation to own and operate a line of flat-bottomed steel freight boats on the Mississippi river, are practically complete and it is probable that the project will be launched shortly.

W. K. Kavanaugh, president of the Lakes-to-the-Gulf Deep Waterways Association, will probably be the president of the new corporation, which is to be known as the Mississippi-Panama Navigation Co. Headquarters have been established at St. Louis, Mo. Governor Charles S. Dineen and Senator William Lorimer, of Illinois, will be among the directors.

The route of the flat-bottomed steel boats will lie between St. Paul and New Orleans.

Three Years in the Canal Zone.*

BY DR. SUMNER COOLIDGE.

TWO professions are vitally interested in the success of the Panama canal—the medical profession, to which the world turned for a solution of the health problem on the Isthmus; and the engineers, whose handiwork is expected to remove mountains and all lesser obstacles that stand in the way of the finished canal. I am not here this evening to attempt a scientific discussion of any phase of the Panama canal, but to tell you of some of the incidents and impressions which go to make one of the most enjoyable and instructive experiences of my life.

The northern public is always interested and generally well informed on canal matters, but when history is being made on the Isthmus so fast that those on the spot have difficulty in keeping up with the work, it is not to be wondered at if you in the north do not keep track of it all.

"What kind of a country is Panama, and how do you like it?" "How can you stand the climate?" "Isn't it awfully hot down there?" are questions asked repeatedly. The city of Panama lies close to the meridian of Buffalo, N. Y., and 9 degrees north of the equator, a latitude where one would expect to have a hot climate. Though not the narrowest part of the Isthmus from ocean to ocean, the strip through which the canal is to be dug contains the lowest point in the mountain range that forms the backbone of the two continents, and consequently the point where the least digging will be required to complete the canal. Of the entire distance of 47 miles between Colon and Panama, the line of the canal lies in swamps a little above sea level through about 17 miles.

The dry season begins early in December and continues till the latter part of April, during which time the refreshing trade winds from the northeast blow continually, the only variation being an occasional "norther," which stirs up a dangerous Caribbean and cuts up interesting capers along the shore. The wet season is a time of many showers. Although 120 to 150 inches of rain fall in seven or eight months, all-day storms are not frequent and many of the nights are clear and beautiful. When the rain storms are long continued, giving insufficient time for the "run-off," freshets result, in which the river may rise 30 to 40 ft. above its usual level. The rain does not prohibit any of the occupations, but amounts only to an inconvenience. The annual rainfall varies widely in different parts of this small canal zone, the records showing a somewhat higher total on the Atlantic side, — 63.16 at La Boes, 135 + at Mt. Hope, for fiscal year 1906-07.

Character of the Canal Zone.

The canal zone as we found it was as tropical as tropical could be, being densely covered from the swamps to the hilltops with a mass of vegetation that was for the most part impassable except through the narrow trails of the natives.

It has been said by one writing of Panama that "her men are without honor, her women without virtue, her flowers without fragrance and her birds without song." The casual observer, crossing the Isthmus by train, hurrying through the uninhabited parts, and seeing little but squalor in the negro villages where the trains stop, observes little of the beauty of the lilies, morning glories, orchids, passion flowers, palms and ferns that abound, though nearly hidden by the rank growth of coarser plants. That song birds are there, too, I know by observation, but, like the fragrance of the flowers, the beauty of their song is hidden by the coarser voices of their kind,—the screeching of parrots and paroquets, which must have impressed the author of the above quotation. Perhaps his estimate of the men and women was influenced by the coarser qualities of the class he saw and heard most of,—but certain it is that standards of honor and virtue in Panama do not exactly coincide with our own.

The temperature ranges between 65 degrees and 90 degrees, and although the humidity is high, the heat is not so oppressive, even for physical exertion, as on our hottest days here in Massachusetts, while the nights are so delightfully cool that almost every one living in a well-ventilated house sleeps under a blanket throughout the year. Americans on the Isthmus have few complaints of the climate, for it amounts to 12 months per year of very agreeable summer weather—and Americans thrive on it—although summer weather becomes monotonous if too long continued.

Attitude of he Panamanians.

The United States paid the Panama government $10,000,000 for the perpetual right of way through a strip of land called the canal zone 10 miles wide and 47 miles long; $40,000,000 to the French company for all of its rights and equipments; and a large sum for the stock of the Panama railroad, the ownership of which was one of the first essentials to the prosecution of the work. The treaty signed by the two governments gave the United States absolute control of the canal zone, but as the 10-mile limit would have included the two principal cities of the young republic, Panama, the capital, and Colon, the Atlantic seaport, these were excepted in the purchase, and in all matters except sanitation are governed by the Panamanians themselves. In the matter of sanitation, however, these cities are quite under our control. We have the right to promulgate and enforce all sanitary regulations deemed proper by the chief sanitary officer.

Although the enforcement must be accomplished and penalties inflicted by the local courts—in the early days often accomplished with difficulty—later developments have proved our treaty with the Panamanians to be an extremely well-executed document, at any rate from the United States standpoint. No doubt it granted us much more than would have been received from an older republic, in fact, more than we should obtain from the Panamanians themselves today, for they never have ceased to feel that they gave us a great deal more than they were willing that we should have.

Trouble With the Panamanians.

In answer to your question, "What kind of people are the Panamanians?" I cannot better demonstrate than by telling you of their attitude toward us and the treaty, which of itself is the only excuse the world has for taking any notice of them. The human nature of the fellow who wanted to "have his pie and eat it too" is intensified in the Panamanians beyond all previous records in my experience. The fact that their two principal cities were being converted from the sloughs of filth and pestilence to clean, up-to-date municipalities by the money and labor of the United States did not seem to mitigate their feelings that we were intruders, and their chagrin that they were not handling the money. It is an actual fact that arrests of American workmen by Panamanian

*From the Journal of the Association of Engineering Societies, read before the Boston Society of Civil Engineers.

police for slight or imaginary offenses while the streets of Panama were being paved and sewered became so frequent and so annoying as to threaten the entire suspension of these operations until the Panamanians could be brought to their senses and made to guarantee the protection of our workmen instead of annoyance. In both Panama and Colon, in 1905 and 1906, Americans were frequently arrested and brutally clubbed when greatly outnumbered by Panama police, in some instances after they had reached the "calaboose."

On one occasion a group of young officers from one of our warships, on shore leave in Colon, were arrested, and after reaching the "calaboose" were severely clubbed. It was with difficulty, and only after much parleying, that a canal commission doctor obtained permission to send the unfortunate prisoners to the hospital for necessary surgical treatment of their wounds. I was present next morning in the little, dirty, dingy room on a second floor on a side street of Colon, where these young men were arraigned before the district judge. The trumped-up charges were carefully written at the dictation of the so-called judge, and the prisoners, cut, bruised and bandaged, had stood up to hear the charges read, when, to our great delight, but to the dismay of the court, there appeared in the doorway, like an apparition, one of the finest specimens of our naval officers, in full uniform, sword and all. Having made his salute to the court, without waiting for recognition, he stated that he had been sent by the commander of the ship to bring the young men on board and to say that if their presence on shore was necessary at any time the commander would be responsible for their appearance. This occurrence stirred the Americans on the Isthmus to such a bitter feeling that trouble seemed imminent. The commander of the ship would have been pleased to turn to and blow the town out of existence, but a little time and hot cables between Washington and Panama led to the whole matter being dropped abruptly. Likewise the arrogant insults of the Panama police.

Ravages of Time.

The Canal Zone as we received it presented a spectacle that beggars description. The ravages of time in such a climate are rapid, and nature quickly covers all traces of man's activities when once they are suspended. The only signs of the white man's enterprise were on the line of the railroad and immediately connected with the business of that corporation, and the hundreds of locomotives, dump cars, excavators, cranes and other machinery, the dwellings, hospitals and shops, and the miles of railroad tracks abandoned to decay or to be overrun by vegetation suggested a graveyard of the most gigantic enterprise, or rather a monument to the most gigantic failure of a good cause the world has ever seen.

The Panama railroad, always one of the best-paying railroads in the world, remains an anomaly in railroad history. Its stock is owned by the United States government, but the business is conducted, as is any railroad business, for profit, to pay interest on bonds still outstanding. Its president is the chairman of the canal commission, the several members of which are the directors of the road. Absolute control of this railroad by the commission has made it possible so to arrange its business that all else is secondary to its service to the canal work. Passenger trains are run in the early morning, at noon, and in the evening, to avoid the working hours of dirt trains and the great volume of through freight, which is still crossing the Isthmus on its way to the United States and Europe, and is transported at night.

Health of the Isthmus.

Of the many problems that confronted the pioneers of this great work none seemed more serious than the health conditions on the Isthmus. The story that tells of the death of a man for each tie used in the construction of the Panama railroad in 1850-55 is only a slight exaggeration of the truth, and the havoc wrought by disease among the French in the period of their greatest activity has given the Isthmus a reputation which the whole world refuses quickly to forget.

When the first canal commission visited the Isthmus in May, 1904, before the property of the French Canal Co. had been formally transferred to the United States government, a careful investigation was made as to the sanitary conditions — the population, the prevailing diseases and other necessary data—in the cities of Colon and Panama, and also in the canal zone. In May, 1904, the population of Panama was 19,000; of Colon, 7,000, and of the villages within the zone, 8,000, a total of 34,000.

In Panama there was no water supply except rain water from the roofs during the rainy season and water delivered by carts during the dry season. The lack of running water made it necessary for each householder to keep one or more barrels, cisterns or tanks in which to store a small supply of fresh water. There was likewise no sewer system except some antiquated underground drains constructed of stone by the earlier inhabitants.

Colon Water Supply.

In Colon the water supply was somewhat better, there being a small pipe line owned by the Panama railroad, which delivered a small quantity of fairly good water into that town. The better classes, however, continued to use rain water from cisterns. Two small sewers were in existence; one, the property of the Panama railroad, the other of the Panama Canal Co.

Along the canal zone there was absolutely no provision for a water supply or sewerage system except at one or two stations where the activities of the old French Canal Co. had been such as to warrant the installation of a local water supply.

It will be observed that the water receptacles in every dwelling, and the swamps about the towns, afforded most favorable breeding places for the stegiomya and anopheles mosquitoes.

The French Canal Co. had built a hospital at Ancon, a suburb of Panama, with a total capacity of 700 when crowded, and in the city stood the old city hospital known as Santo Tomas, with a capacity of about 350 beds. In Colon were two hospitals—one of 35 beds owned by the Panama railroad; the other of 50 beds owned by the French Canal Co. With the exception of the railroad hospital at Colon, all hospital buildings were out of repair and in an unsanitary condition. Nor was any attempt made to keep the buildings or grounds from deterioration, some of the wards at Ancon being entirely hidden from view by the tropical vegetation that quickly sprang up when the French activities began to subside.

Diseases of Panama.

The prevailing diseases were yellow fever, beri-beri, tuberculosis, malaria, pneumonia, typhoid and dysentery. Statistics of these diseases, which were kept during the operations of the French Canal Co., 1881-1904, not only suggest a picture of the awful havoc wrought by disease upon the working force, but afford a most interesting comparison with the methods and results of the later enterprise.

The French began operations in

1881, and in December, 1883, the total number of employes had reached 10,000. In October, 1884, the maximum of 19,000 was reached, and an average number of about 15,000 or 16,000 was maintained until 1888, when it fell rapidly, reaching 900 in September, 1889. A total working force of about 700 men was then continued on the Isthmus until 1895, when a feeble attempt was made to renew active work on the canal, but the total number of employes never exceeded 4,000. In 1884, of an average total of about 18,000 employes, the deaths numbered 1,232, an annual death-rate of 70.13 per 1,000.

From the beginning of the United States occupation it was recognized that the success or failure of the enterprise would depend not upon the solution of any engineering problems, complex as these appeared, but upon the outcome of the campaign against yellow fever. It had been noted that the introduction of large numbers of non-immunes into a country where yellow fever was endemic was invariably followed by an epidemic of the disease, the severity of which varied in direct proportion to the number of non-immunes introduced, and it was well known that an epidemic would soon develop on the Isthmus after the arrival of the American workmen unless aborted by some means. The first step in the campaign against Isthmian diseases was the organization of a working force that would cover effectively and at once all parts of the field. To this end the department of health was made to consist of the following divisions:

1. Hospital division, which attended to the sick and injured.
2. Sanitary division, which instituted an active campaign against filth and mosquitoes; and
3. The quarantine division, whose duty it was to prevent the introduction of new sources of infection.

Division of Municipal Engineering.

Hand in hand with this sanitary organization the engineering department created a division of municipal engineering which should at once proceed with the introduction of sewers, water supplies and paving to make permanent the results of other sanitary measures. Of the sum total of sanitary procedures employed, the greater part had to do directly or indirectly with a war against mosquitoes. It had been learned by actual experiment in Cuba that yellow fever was transmitted only by a certain variety of mosquito (stegiomya), whose habits of life and propagation had become well understood, and it was the application of this knowledge in the campaign in Panama that produced the results which have amazed the world, and of which we may justly feel proud. Briefly, the handling of the yellow fever question was as follows: Cases were admitted to the hospitals promptly and screened for a few days to prevent the infection of mosquitoes in the wards that would transmit the disease to other men; the quarters from which cases were taken, and houses recently visited by them, were fumigated by the "fumigation brigade," to kill all mosquitoes that might have bitten the patient before he was admitted to the hospital, and a relentless campaign was carried on against this special mosquito in its breeding places by the stegiomya brigade, with the purpose of exterminating the species as nearly as possible.

Yellow Fever Transmitted by Mosquitoes.

This stegiomya mosquito, the transmitter of yellow fever, is rather domestic in its habits, preferring to live and breed in and about human dwellings; and when you consider that the entire water supply of the community was from open tanks, barrels or tubs kept full by rain in the wet season and scantily supplied from carts in the dry season, you will appreciate the task of inspecting every water container in the city at least once every six days, and covering and spigotting those that might not be destroyed. This inspection of every room in every house was resented by many of the Panamanians as an intrusion, and they did not hesitate to obstruct the work repeatedly. Then, again, the delays in obtaining supplies as ordered were most disheartening in the early days. Orders of the chief sanitary officer were often cut one-half or even more reduced, and shipments were exasperatingly slow after the goods were bought.

The Last Case of Yellow Fever.

Through that trying period, April to August, 1905, when yellow fever claimed so many victims, when Mr. Wallace's resignation became the signal for an exodus from the Isthmus that well nigh assumed the proportions of a stampede, and when high officials on the Isthmus became so skeptical of the methods of the chief sanitary officer that they were ready to ask for his recall his confidence in his ultimate success was unshaken, and the patience and courage with which he kept his shoulder to the wheel may well be remembered in these later days when there appears to be a disposition in some quarters to question his share of the credit for present conditions. The last case of yellow fever originating on the Isthmus occurred in May, 1906, and there is no danger of a reappearance except as an importation from some of the infected ports within a few days' sail of the canal. It is safe to say that over one-half the physicians on the Isthmus today have never seen a case of yellow fever. The total number of cases since the American occupation was 246, with 83 deaths.

Prevalence of Malaria.

But, after all, yellow fever was not the disease that most interfered with canal operations, except that its high mortality (one-third of all cases) alarmed employees and prospective employees. The disease that causes more loss of time among the workmen than all other diseases combined, and consequently the most important economically, is malaria, the severest types of which are found on the Isthmus. Malaria is also transmitted from man to man by a certain mosquito (the anopheles), whose habitat is in the vicinity of swamps and pools and slowly moving streams. The anopheles is everywhere in Panama, except where her haunts have been destroyed by the anopheles brigade. A peculiarity of this pest is that she does not fly far from her native haunts except in the protection of vegetation or buildings. The campaign against malaria, then, consists of cutting vegetation about inhabited dwellings for a distance of about 1,000 ft., perfecting surface drainage to reduce the number of breeding places, and oiling those waters that cannot be drained away, screening houses and administering prophylactic doses of quinine daily to those who are not sick. The general distribution of the mosquito that transmits malaria and the presence of the malarial parasite in the blood of 70-80 per cent of the native population as determined by actual blood examinations, the only two conditions necessary for perpetuating the disease, is evidence enough that malaria will never be eradicated from the Isthmus, as was the case with yellow fever, but the sum total of anti-malarial procedures has so far reduced the prevalence of the disease that the sick rate among canal em-

ployes today is lower than in the United States army and navy, and as good as on any similar work in the north.

While yellow fever has caused the greatest alarm and malaria the greatest loss of time, the disease that for months caused the greatest number of deaths among employees is pneumonia. Deaths from pneumonia among whites are very rare, but negroes seem to have not the slightest resistance and die of this disease with alarming rapidity. Fifty per cent of all cases in negroes die.

Care of the Negroes.

The medical care of the great army of canal employees has been often amusing, occasionally exciting and always interesting. The West Indian negro is mild of temper, credulous, usually courteous and takes himself very seriously. He is only a child in his intellect and his emotions, and when treated as such is not a bad sort. He is a glutton for medicine, is made so truly miserable by his exaggerations of his little indispositions that his descriptions of his symptoms are as amusing as they are graphic. One poor fellow whose woebegone countenance looked as if he had never smiled approached me and, in a voice full of tears, said, "Doctor, in de mornin' I has dark eyes, and, doctor, a giddiness in ma head, and a neediness in my bowels." Another was not sick, but wanted some medicine for a cold. His only symptom was a slight stomach-ache, which he explained by saying, "Doctor, ah works in de water an ah takes cold in ma feet, an de cole abstrack up out of de feet and wind 'roun' de nabal." But nature has never suggested to him that he lay up a winter's store, or that he produce what he needs to eat; in fact, she lays it at his door and he needs but to partake. He is attracted to the Isthmus by the prospect of high pay in the employ of the canal, but he has no notion of working hard or continuously.

Inspecting the Labor Camps.

In the winter of 1905-06 it became my duty to institute a daily inspection of all labor camps in Cristobal, and in making my rounds I was surprised at the number of men in camp during working hours. Some were sick, some informed me that they had "worked hard" the day before and needed "a little rest," and not a few (of English persuasion) answered my questions as to their reasons for not working in a most supercilious manner, "Ah didn't fawncy to work today, sah!" But there has been a great weeding out of deadwood among the negroes and they have profited by their compulsory education in diligence and hygienic living, so that as a body they are much more efficient than two or three years ago. I said *compulsory* education At first they did not like the food we offered them and preferred a starvation diet, which they prepared for themselves and which made them an easy prey to disease; but when compelled to eat at commission kitchens and to sleep in well-ventilated buildings, or lose their positions, their condition steadily improved and now, like children, they are happier for their little punishment. Besides about 30,000 negroes there are some 60 other nationalities represented among the canal employees, the most efficient of which are the Spaniards and Italians brought from Europe by contract.

Beside the medical and the mosquito work of the sanitary department a large force of men was kept busy for over a year digging out and removing the accumulations of filth of many years, especially in Colon and Panama. Thousands upon thousands of cart loads of rubbish, garbage and other filth were removed from the narrow alleys and little back yards, where it had been thrown for years and left for nature to dispose of. One of our greatest offenses against the feelings of the natives was our open-air treatment of their dirty condition, which required the removal of the high, close fences with which they had surrounded their little dooryards with their disgusting accumulations. Up to the time that sewers were completed night soil was disposed of by the bucket brigade system in the cities, and by pit closets in less thickly populated districts.

Survey for Water Supply.

While this sanitary work was going on, the division of municipal engineering made preliminary surveys for water supplies and sewers for Colon, Panama and for all important towns along the canal, beside providing distilled or sterilized drinking water for all the white employees on the Isthmus. It was not necessary to lay pipes 5 or 6 ft. under ground to escape frost, and the work was pushed forward without delay, so that the city of Panama was ready to receive its water supply on July 4, 1906. About a year later the Colon water works were completed, and soon all the towns in the zone had sewers and water supplies as good as the average town of the north. It has been found that the tropical streams of the Isthmus furnish excellent water supplies, which, although containing considerable organic matter, are palatable and safe. Bacteriological examinations of all water supplies are made weekly, and copper sulphate is used successfully to inhibit growth of algae.

Panama City's Water Reservoir.

The source of supply for the city of Panama, a reservoir of 500,000,000 gal., is 13 miles inland toward the head waters of the little Rio Grande, whose lower valley is to form the southern end of the canal. The elevation of the reservoir is 232 ft. (its area, 65 acres), so that there is plenty of head for all except the higher buildings at Ancon hospital. The 16-in. main, by which the water is brought to the city, is tapped by five small towns on the way, and through most of the distance lies on top of the ground or only slightly covered. The Colon water supply is about four miles from the city in the rather shallow basin of Brazos Brook, a reservoir 122 acres in area. Its capacity is 435,000,000 gallons, but as its high-water elevation is only 45.1, the water is pumped into a standpipe, from which it flows through a 20-in. main to the city. The water for both Colon and Panama is filtered through sand beds under pressure and is metered to the cities by Venturi meters and again metered to consumers, the difference between the Venturi reading and the total of service meter readings being the amount charged to the municipality. The water to consumers costs in Panama 25 cents per 1,000 gal.; in Colon, 40 cents. Hydrants are charged at $49.68 each. Besides the fire hydrants there are curbstone taps, located two blocks apart, from which the poor may draw water without charge. These are paid for by the city. Sewers and water works, when completed, were handed over to the Department of Public Works, a branch of the Department of Civil Government. It is expected that water rates and sewer charges which are collected by this department will, in fifty years, reimburse us for the entire expense of the sanitation of Colon and Panama.

The construction of the Panama Canal sewers was a simple matter, as there was plenty of grade to the ocean in several directions, but in Colon was another proposition. Manzanillo Island, on which Colon is situated, is an old coral reef, the surface of which is only about 1 to 3 ft. above sea level, in consequence of which a considerable proportion of the sewer system is at or below sea level. Sewage is delivered into a sump in the center of the city, 27

ft. square and 21 ft. 6 in. deep, from which it is pumped through 1,115 ft. of 10-in. cast iron pipe to a drainage canal leading to Manzanillo Bay. Surface water is carried directly to the sea, to the drainage canals, two of which have been cut across the island, admitting tide water to the swamps in the middle of the island. The maximum tidal wave at Colon is about 3 ft.; at Panama about 20 ft.

Closely following the installation of water pipes and sewers came the paving, the two divisions being in some instances only a few hundred feet apart. The principal streets were paved with vitrified brick on a concrete or macadam foundation; others were paved with concrete or macadam, and substantial concrete curbs and gutters were laid in all.

Completion of Sanitation Campaign.

With the completion of sewers, water supplies and paving, yellow fever eradicated, malaria under control and no epidemic diseases to deal with, the first great step in Isthmian sanitation was accomplished, and since the later months of 1907 we have tried to maintain the favorable conditions then existing, improving here and there where found practicable. Since 1905 the annual death rate of all employes has been reduced from 33.52 per 1,000 to 12.78 per 1,000; negro death rate from 67.81 per 1,000 to 10.65 per 1,000; sick rate from 42 per 1,000 to 25.09 per 1.000; malaria, 400 cases less in September, 1908, than September, 1907.

The lateness of the hour forbids that I should dwell upon the every-day life of Americans on the Isthmus. Suffice it to say that out of what we called the "tin-can period," when we lived out of cans and jars, or at the local cantinas, there slowly developed a cold storage and ice plant, a steam laundry, a bakery, commission hotels and a well-systematized commissary, which, with the comfortable quarters, free electric lights, free running water, free coal for cooking and elaborate provision for social betterment make life on the Isthmus as comfortable as it is here at home. Wages are some 60 per cent higher and the cost of living somewhat lower than in the States, and it is safe to say that there is no other place in the world where men can live so comfortably and at the same time save so much of their earnings as on the Isthmus of Panama. The employee has always within his reach the means for intellectual, physical, social or spiritual improvement, and no one to dictate which he shall select. My own experience as leader of the band, whose concerts were of necessity given on Sunday afternoons; as chairman of the council of the Y. M. C. A., which rather frowns on Sunday dissipations; as president of the baseball association, which plays all its games on Sundays, and as family physician to the canal officials, gives you a sample of incongruous conventionalities reconciled by circumstances.

There are about 6,000 American employees at work on the canal, whose families aggregate some 2,000 women and children.

Every-Day Life on the Isthmus.

But time has flown and I have not told you anything about the "ditch." I believe that some of you here have asked me since my return, "What kind of a canal is it to be?" "Are they really making any progress?" "When will the canal be finished?" or "Will it ever be finished?" When I tell you that as great changes have taken place in the average Massachusetts town in about 300 years you will understand the confidence of all the men on the work in its early and successful completion. No one on the Isthmus wonders if the canal will ever be finished. On the contrary, they are wondering down there what their next job will be. The dirt is not "flying," but it is pouring out of the canal prism like a mighty stream. To one standing on the brink of the cut at Culebra, as he watches the sinuous movements of dirt trains winding their way out of the cut, it almost seems that the earth has taken life and is crawling away of its own accord. No digging is done by hand; rock is broken by blasting so as to be loaded by steam shovels, and is plowed from the long flat cars or dumped from dump cars in which it is transported.

With all our admiration for our own accomplishments in canal digging on the Isthmus we wonder more and more at the work accomplished by the French. With their diminutive excavating machinery, tiny locomotives and dump cars, handling a great deal of material by hand, they cut the Gold Hill to a depth of some 150 ft., tunneled hills to divert rivers, built a beautiful hospital and comfortable quarters for their employees and left many examples of the refinement of technical skill that characterizes all their work.

The canal is to be a lock canal, about seven miles at each end being at sea level, about four miles at an elevation of 55 ft., and some thirty miles at 85 ft. above sea level. The portion between Gatun and Bas Obispo will form a great lake through which vessels may steam at full speed in either direction for a distance of 23 miles, and the locks are to be constructed in duplicate, so that passage will be possible in either direction at all times.

That I am an enthusiast on Isthmian life and on the prospects of the canal I admit, and if you will accept my suggestion and take a winter trip to Panama, you will come back as enthusiastic as I, although you will never be able to appreciate the changes that have been wrought there in the last three years. I should be pleased to have you come in contact with the source of my enthusiasm and be convinced, as I am, that the Panama Canal will be finished and in use before 1915.

S. S. LUCANIA BURNED.

On Aug. 14, the Cunard Line steamship Lucania was seriously damaged by fire, she having been almost gutted from her funnels forward. In order to check the fire it was found necessary to flood the vessel at the dock. She was floated shortly after and will be towed to Glasgow for repairs. Her machinery has not been damaged but many of the hull plates forward are warped by the heat and some of the decks are badly buckled. The first saloon skylight was entirely destroyed.

The Lucania was built in 1893 in the shipyards of the Fairfield Co. in Glasgow. She is a twin screw steel vessel, schooner rigged, and equipped with quadruple expansion engines of 3,191 nominal H. P. Her dimensions are 601 ft. length, 65 ft. 2 in. beam, 37½ ft. depth of hold, and she is of 12,000 gross tonnage. In October, 1894, the Lucania wrested the westbound Atlantic record from the Campania, making the passage in 5 days 7 hours 23 minutes, which was 4 hours 44 minutes better than that of her sister ship. She carried the Cunard line's commodore's pennant until the advent of the Lusitania.

The brass figureheads on American men-of-war are to be removed. This decision has been reached at the navy department after long consideration. Chief Constructor Capps some time ago made the recommendation to Secretary Meyer, and the secretary has made the order accordingly. The figureheads are usually made of brass and they shine brightly in the sun. This destroys the efficiency of a ship in time of peace maneuvers as a vessel can be much more easily seen. In time of war the ornaments are painted.

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A NEW KINK IN NAVAL ARCHITECTURE.

A prominent naval architect used to say that ship building was not an exact science, because if it were there would be no failures, the personal equation would be eliminated and results could be predicted with certainty. That this is not the case, almost every day furnishes proof. In an address at the joint summer meeting of the Institution of Engineers and Ship Builders of Scotland and the Northeast Coast Institution of Engineers and Ship Builders, held at Glasgow, Dr. G. B. Hunter said: "Ship building is an exact science." This, however, was before the performance of the Monitoria, referred to elsewhere, had come to confound him. That a crimp or two in a ship's side, giving her the section of a battered washboard, should have what might fairly be called such revolutionary effects, is sufficiently startling and, on first thought, almost comic. But there appears no reason to doubt the results claimed for it. It is a long time since any innovation of approximate importance in ship building came to us, and to cut down fuel consumption 15 per cent and at the same time increase dead weight capacity 3½ to 4 per cent is no small matter in a cargo ship. It means more to the ship owner than the advent of the triple-expansion engine. Speculation as to the effect of the corrugations in higher speed vessels of various types, including side-wheel steamers, is interesting, even if unprofitable, and we may be sure that the possibilities of this departure are not exhausted.

THE VIBRATIONS OF SHIPS.

Few phenomena have been the subject of abstruse papers or served as a text for learned discussions oftener than the title of this article. The work of Schlick, Yarrow, Taylor, Macalpine, Melville and others forms a formidable array of outgiving on the general subject, while the lectures and inventions springing therefrom are beyond computation. In most, if not all, cases it has been assumed that the whole trouble lay with the engines. In all the treatises on the subject it is treated from this standpoint. Yarrow satisfied himself that in a specific case certain observed periods of vibration were due to the engines and built thereon a theory intended to be applicable to all cases. Schlick also had his theory, based on the assumption that the engine was the sole cause of disturbance. Taylor was the first to touch the real trouble and, while attacking it intelligently and effectively, to concede that not only did the causes of vibration frequently lie entirely outside the engine but also frequently were not curable by engine treatment. Melville, while analyzing the disturbing forces and suggesting their treatment says that the so-called "systems" have their chief value in cases "where it is of importance to claim that at least an effort has been made to solve the problem." There is not a doubt that many an extra has been paid on contracts because the engines were to be balanced on somebody's system. As a bald matter of fact, there is no known instance where anybody's system either prevented or cured vibration. The fact that a ship does not vibrate proves absolutely nothing, neither does the fact that she does vibrate prove that the trouble is due to the engines, or lack of balance, nor in fact to anything definite whatever. If, as some assert, the question is solely one of balancing or eliminating disturbing weights and forces, why will a given ship which has exhibited no tendency to vibrate in deep water set up violent vibration on entering shoal, although no condition has been changed? Many ships have been known to be perfectly still in shoal water and threaten to break in two when in deep water with engine speeds exactly the same in each case. Ships with engines balanced most carefully and scientifically on well known "systems" have been notoriously among the worst offenders, while others in which all system was calmly ignored have proven marked successes.

Almost all the attempts at scientifically correct balancing have dealt with four-crank engines, except possibly Macalpine's, of which, so far as we know, there are no examples, and the system known as Yarrow-Schlick-Tweedy is probably the most widely known. That it or any other system has ever prevented vibration has yet to be demonstrated. It is not denied that ships with engines balanced on that system have apparently been successful, but it is also true that just as many have not been. Considering that the engines with normal crank arrangement are many times the more numerous, the showing is certainly not convincing.

Eighteen years ago D. W. Taylor suggested a method of crank arrangement involving no calculation whatever, which so closely approximates the Y.-S.-T. system for any given four-crank engine, and eliminates possible errors in computation, much of which is estimated, that it is just as likely to be successful as the latter,

and has been used with apparently the most completely satisfactory results. There are scores of ships with quadruple and four-crank triple engines in which no attempt has been made at balancing, which are also perfectly satisfactory. But none are free from disturbance under certain conditions, and it is also true that in the most aggravated case vibration is absent under certain conditions.

This by way of introduction to a discussion of the deductions in Prof. Henderson's paper in the June REVIEW.

This appears to us to be an extreme case of endeavoring to make facts fit a preconceived theory and at the same time show why they do not; thus proving the case either way. It is moreover based on fallacious assumptions, as where he says, "In ships the amplitude of vibration is, as a rule, negligible, unless there is approximate equality in the period." Attention has been called time and again to severe cases in ships without machinery at all, and consequently no regularity of period. It supports, however, the doctrine which has been consistently advanced by the REVIEW that the propeller is frequently responsible for vibration. We believe that we cannot insist too often that of remediable disturbances the chief, and practically all of any consequence, are due to the propeller. If a fraction of the study and care given to the subject of balancing were given to the propeller, we would hear less of vibration.

The turbine was to have relieved both builders and travelers of all annoyance in this respect, thanks to the enthusiasm of the uninformed, among whom may be classed many owners and managers who were, and are still, possessed by the idea that the engine was at the root of all disturbance. As a matter of fact, however, the turbine has only succeeded in pointing out the necessity of seeking other explanations, and in the absence of reciprocating or rotative unbalanced weights the propeller has been arraigned as the criminal, and while it is undoubtedly chargeable with a greater measure of responsibility than any other cause, it is by no means solely responsible even in turbine ships, as is sought to be shown. The trim of the ship, stowage of weights, water ballast, weather, speed, all have their effect on any given ship, and no known type of motor or system of balancing or form of propeller will meet all conditions successfully.

Prof. Henderson draws deductions based on treating the ship as a bar with consequent inherent harmonic characteristics. Any degree of familiarity with ships would seem to have prohibited such an assumption. Every change in distribution of weights must change the characteristics. A change in cut-offs without any change in weights or revolutions will do the same thing. On a long voyage the burning out of the bunkers will bring about a change; as a matter of fact there is no such thing as formulating a law on the subject, or framing rules which will apply under any two varying conditions.

Prof. Henderson is quite convinced that the law of harmonics accounts for everything, which we do not dispute, since any conceivable case will surely be found to be explained by some one or other of his hypotheses. But what we want is some way of determining beforehand what is to be expected with reasonable certainty and how to meet the condition; not to explain it afterwards, and we maintain that at present that knowlege is absolutely wanting. Analyzing impulses and disturbances after they occur and after it is too late to bring things to accord with a guesswork theory may be interesting as a study, but it is inconclusive and without practical value. Not the slightest evidence is yet forthcoming that anyone's theory or system has ever prevented or cured a case of vibration, while instances are abundant of their failure. Where there is one ship fitted on any system running smoothly, there are fifty with no system at all doing equally well. Neither system nor lack of it meets all conditions. Careful construction and ajustment of the propeller will do more than anything else to prevent vibration, but if any owner expects that the adoption of turbines or any empirical "system" will insure absence of vibration, he is misled.

THE STATUS OF THE TURBINE.

Elsewhere will be found an abstract of a paper contributed by Prof. Ira N. Hollis to the *Engineering Magazine,* which emphasizes the rearward movement of the recently clamorous turbine advocates. Prof. Hollis, although for some years connected with Harvard University, is not without marine experience, both afloat and ashore, having reached the grade of chief engineer in the United States navy before going to Harvard.

We invite attention to the relative propeller efficiencies which Prof. Hollis quotes from the acceptance trials of United States cruisers. We are accustomed to hear claims of superior economy in coal consumption per horsepower advanced on behalf of the turbine, although there is not yet forthcoming the slightest evidence in support of this as regards marine installations. We may yet be perfectly willing to concede a large gain in fuel economy per horsepower without in any way detracting from the superior efficiency of the reciprocating engine. For instance, take the figures for the Birmingham, Salem and Chester at 22½ knots and compare the slip percentages. It will be seen that the slip percentages are almost 50 per cent higher for the turbine than for the reciprocating engine. It would require a very considerable gain in steam economy to even counterbalance the falling off in propeller efficiency. It will be seen that at all speeds the propeller efficiencies of the Birmingham are immensely superior to both the Salem and Chester.

The vibration question appears in a new light, but we are disposed to think that very few will agree with Prof. Hollis' conclusions on this point. So far as commercial applications are concerned, we think the question of vibration will cut a very large figure, and the recent experience of the Mauretania and Lusitania is a case in point.

The turbine is in its proper place in the naval ship and in the high speed passenger ship, but if its adop-

tion in the merchant marine is dependent upon the development of a satisfactory speed-reducing gear to bridge over the gap between the high rotative speed of the turbine and the low speed at which the best propeller efficiency is had in merchant ships, we think its day will be long delayed, not because such a gear may not be forthcoming but because of the consequent introduction of a feature bristling with trouble at a critical point, which might be well enough ashore, but has no proper place aboard ship.

THE WESTINGHOUSE PROPELLER EXPERIMENTS.

It has often happened that the by-product of a set of experiments has proved to be of as high or higher value than the subject under investigation. George Westinghouse, starting out on experimental investigations for an entirely different purpose, and with characteristic thoroughness overlooking no detail, develops some valuable information on that perplexing and imperfectly understood subject, the screw propeller, which, if followed up, as it doubtless will be, may greatly enlarge our knowledge of it.

For instance, he discovers that no thrust is developed along the center line of the driving face, but rather the contrary, a phenomenon in itself full of incentive to further research.

The remarkable falling off in efficiency, amounting to 50 per cent with an area reduction of probably not over 25 per cent, is in line with the results obtained by others with certain types, but it is safe to say that no one has ever assumed that at any point in the wake within the disk area of the propeller a negative pressure existed. To be sure a tip velocity of 12,000 ft. per minute is beyond any standard propeller practice, but it is too soon to say that succeeding experiments may not demonstrate that it is permissible. There is ample food for thought and warrant for further investigation in the interesting facts so far developed.

It is stated on apparently good authority that Rear Admiral Melville, late Engineer-in-Chief of the Navy, has been associated with Mr. Westinghouse in these experiments.

A NATIONAL DISGRACE.

Elsewhere in this issue will be found a brief description of the new Japanese trans-Pacific liner Tacoma Maru. The vessel was built in Japan and is manned completely by Japanese officers and men. The Tacoma Maru is a credit to the merchant marine of the world and to the skill, energy and business foresight of the Japanese nation. So far as the Japanese are concerned with the building and navigating of these steamers THE MARINE REVIEW has nothing to offer except its highest compliments.

But as patriotic Americans we must deeply deplore those conditions that have made it necessary for the fleet which connects the western terminus of a great American railroad with the far east to be built in a foreign land and operated under a foreign flag.

The construction of the Chicago, Milwaukee & Puget Sound railway from the Mississippi valley to the Pacific coast is a triumph of American capital, engineering genius and business ability But that the ocean feeder for this great system shou'd be under foreign control is a disgrace to the American flag.

In building the Tacoma Maru and Seattle Maru in Japan, the Chicago, Milwaukee & Puget Sound interests take advantage of Japanese construction bounties. In operating these vessels under the Japanese flag, the fleet receives subsidies from the Japanese government, which reduce its operating expenses and enable it to assist in still further crushing the life out of American shipping on the Pacific. We have no quarrel with the American railroad interests in this matter. To operate these vessels under the American flag without government aid would be financial suicide. Our quarrel is with the congress that allows such conditions to exist and with certain middle west legislators in particu'ar, who, apparently cannot perceive the great national loss that the construction of these vessels and others entails, and who steadfastly refuse to assist in remedying matters.

How generously the operation of this fleet will enrich the Japanese capitalists! What splendid training ships for the Japanese navy these vessels are! What excellent colliers or transports they would be in time of war!

Will we never wake up?

NEW STEAMSHIP LINES TO THE ISTHMUS.

Bernard N. Baker of Baltimore who has, at the instance of President Taft, been investigating the matter of freight rates over the Panama railroad, owned by the United States government, has prepared his final report to the President bearing on the alleged discriminations of the Panama railroad and Panama Steamship company against American commerce crossing the Isthmus.

In this report Mr. Baker recommends that the government, by the aid of the mail service contracts, encourage the establishment of an independent line or lines of steamers on each coast, which shall connect with the Panama railroad.

The plan proposed is comprehensive and does not, as has been urged, contemplate that the government shall enter the steamship business. It simply provides that by means of postal contracts one line of new and up-to-date steamers shall be established on the west coast, connecting Seattle, Portland, San Francisco and San Diego with Panama, and on the east connecting New York and New Orleans with Colon.

These two lines would, of course, use the Panama railroad for transshipments and Mr. Baker urges that the government establish a flat rate across the Isthmus for all shipments, whatever their origin.

This, he argues, would remove the prerating systems which are now used to foster foreign commerce and which he claims now places American shippers out of the running, so far as possible competition is concerned.

Mr. Baker believes that the mail contracts will be sufficient encouragement to money interests to establish the new steamers. He says that he has no interest and will have no financial interest in any line which may be started, but that he has assurances that the money will be forthcoming if the present administration will exercise its rights under the postal laws and award the mail contracts as outlined above.

United States Fleet Colliers Vestal and Prometheus

THE first details so far made public regarding the two fleet colliers authorized in the act of April, 1904, are presented herewith: One of these ships, the Vestal, is under construction at the New York navy yard, the second, the Prometheus, at the Mare Island yard. They were authorized under the names Erie and Ontario, but following the practice inaugurated with the purchase of fleet colliers in 1898, they were subsequently changed as above.

The amount appropriated for their construction was $3,100,000, and the time allowed for construction 22 months, but when it was decided that they should be built in government yards the time allowance was eliminated. The ships are designed to carry 6,400 tons of cargo coal and 1,553 tons of bunker coal on 26 ft. draught, and to have a speed of 16 knots loaded and carry a complement of 232 officers and crew.

Their length between perpendiculars is 450 ft. and 465 ft. 10 in. over all; beam molded 60 ft., depth molded to main deck, 36 ft. 6 in.; displacement at 26 ft., 12,500 tons, giving a block coefficient of 0.62.

They are fitted with twin screws and the propelling machinery consists of two sets of three-crank triple-expansion engines with cylinders

$$\frac{28 \text{ in.} - 44\tfrac{1}{2} \text{ in.} - 75 \text{ in.}}{54 \text{ in.}}$$

with a collective indicated horsepower of 7,500 at 86 revolutions per minute with steam at 185 lb.

The engines are fitted with piston valves throughout, operated by Marshall gear. They are both placed in the same compartment, which is, of course, watertight. All shafting is hollow forged and the crank shafts are 15 in. diameter with 5-in. axial hole.

The propellers are of manganese bronze, three-bladed, 17 ft. diameter, with pitch adjustable from 21 ft. to 23 ft.; area developed 148.8 sq. ft.; projected 118.6 sq. ft., and turn outboard.

The stern bearings are carried by struts, two each side, at frames 141 and 153, 20 ft. and 44 ft. respectively, forward of aft perpendicular, while the penetration of the hull is at frame 131. As the shafts are approximately 20

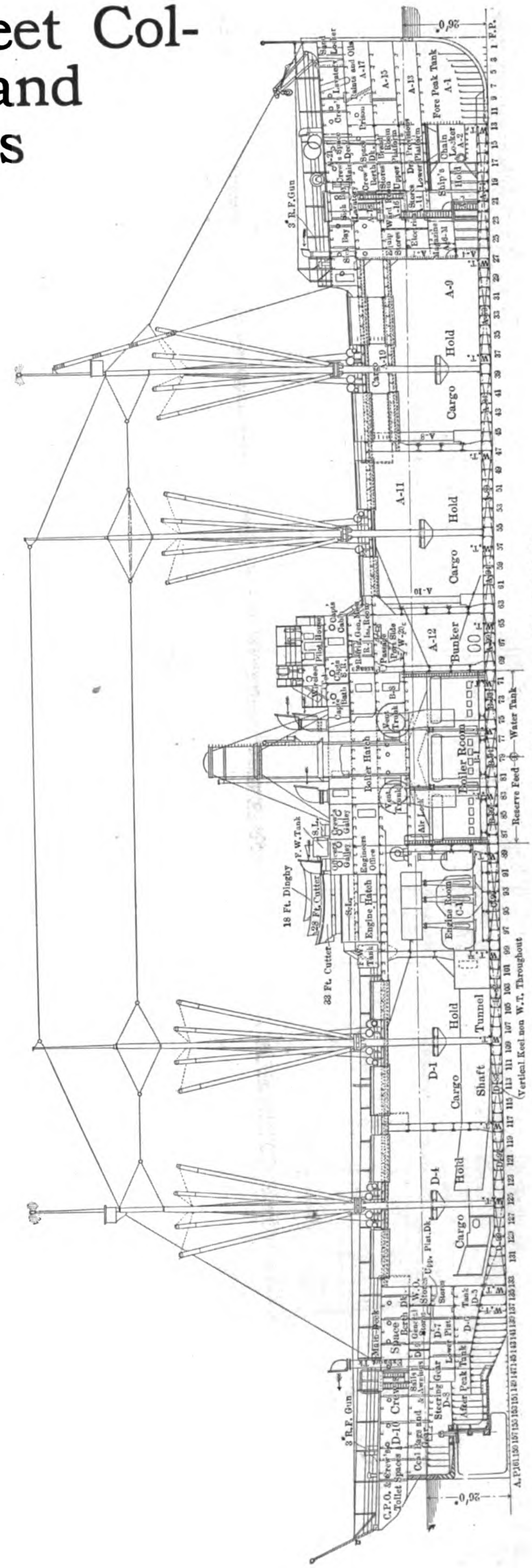


FIG. 1—LONGITUDINAL SECTION. VESTAL AND PROMETHEUS.

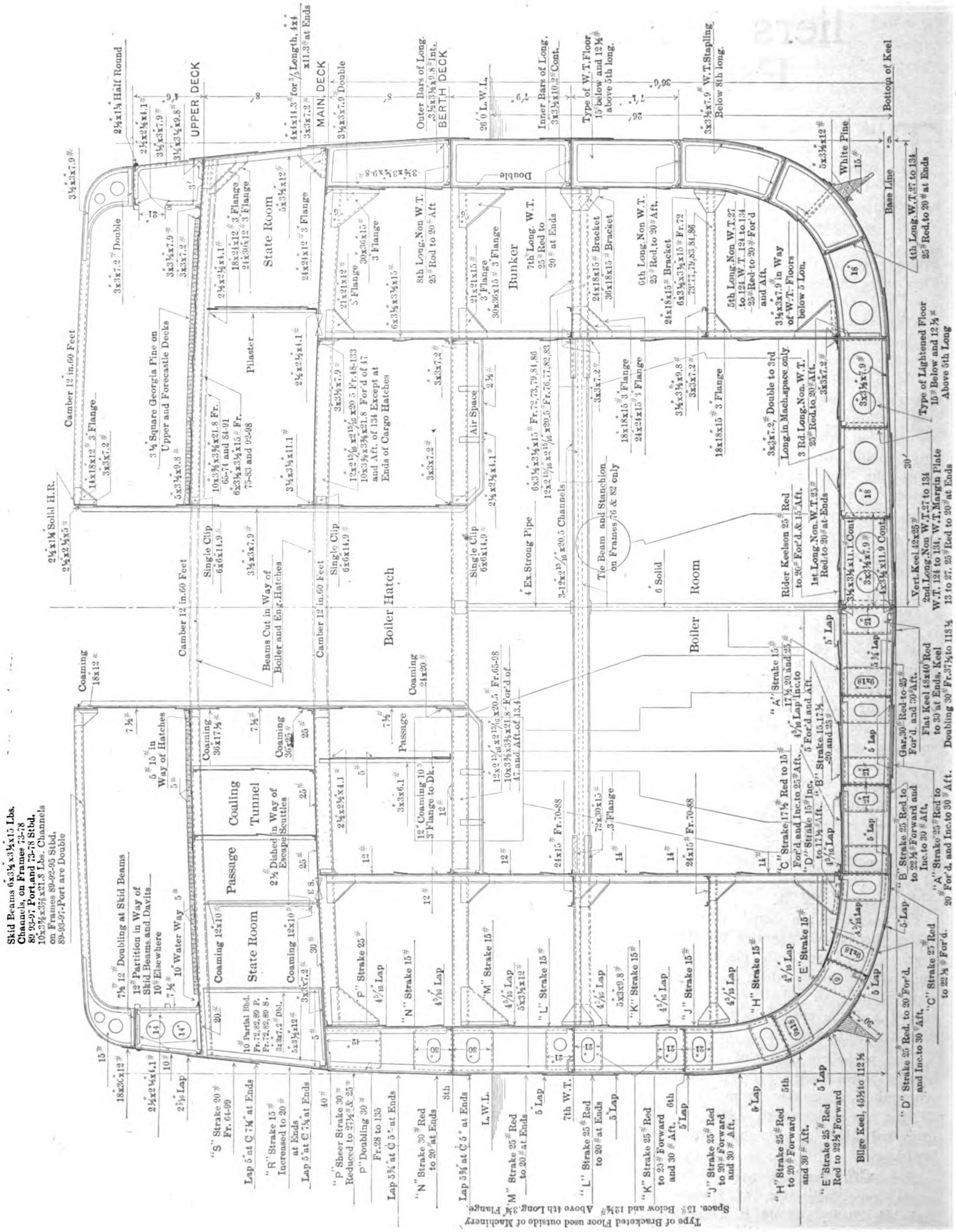


FIG. 2—MIDSHIP SECTION, VESTAL AND PROMETHEUS.

ft. centers, the fineness of the lines is apparent.

Fairwater sleeves in halves are fitted to struts and stern tube.

Each main condenser contains 1,200 tubes ⅞-in. outside diameter, 19 ft. 4½ in. long, giving about 5,300 sq. ft.

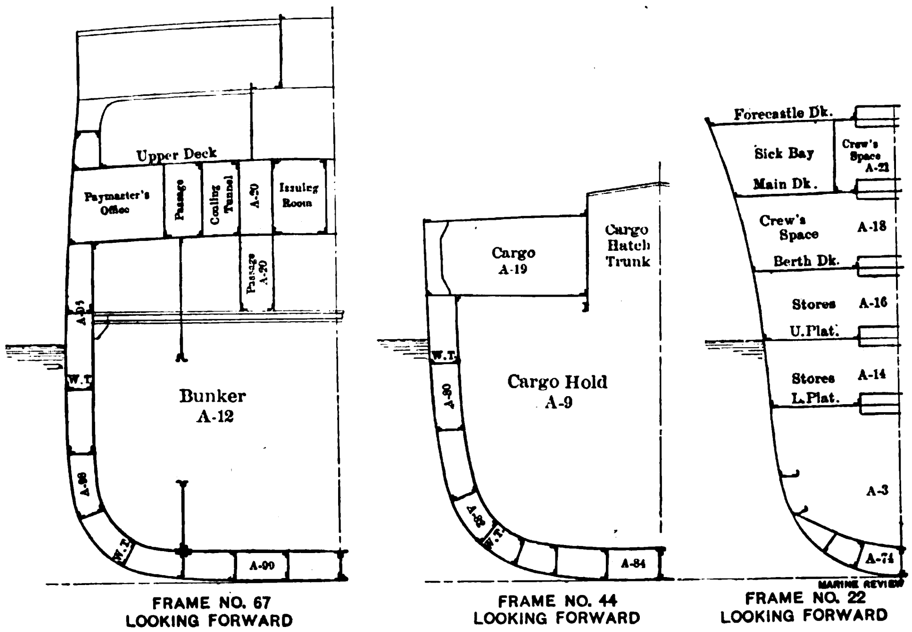


FIG. 3—HALF SECTIONS. VESTAL AND PROMETHEUS.

of surface; the auxiliary condenser about 600 sq. ft.

The air, feed and bilge pumps are driven from the main engines, the circulating pumps are independent and of the usual centrifugal type, with 14½-in. connections, to sea, main drainage system, condenser and overboard. In addition to the attached feed pumps there are fitted two independent single feed pumps 14 x 8½ x 12 in., one in engine room and one in boiler room. There are fitted two fire pumps, 14 x 8½ x 12 in. and 12 x 10 x 12 in., both single, in fire room and engine room respectively.

There is one ballast pump, single 14 x 14 x 14 in., fitted to pump either into or out of double bottom.

The evaporating and distilling plant is in duplicate, with an aggregate capacity of 7,500 gals. in 24 hours, and equipped with the usual fresh water and circulating pumps.

There are six boilers of water tube type, with a total grate area of about 500 sq. ft., with 7-ft. grates and total heating surface of about 22,000 sq. ft., placed in one compartment and designed to work under forced draft on the closed stokehold system. The capacity is equal to running all machinery on board at full power with an air pressure of not over 2 in. at ashpits. Tubes are of seamless, cold-drawn steel. Four blowers are fitted on berth deck, delivering to boiler room below. The single stack is 90 ft. high above base line and about 9 ft. 6 in. in diameter. The working pressure is 225 lb. reduced to 185 lb. at engines.

A work shop is provided on the berth deck over the boiler room, containing one 28-48-in. gap lathe, one 14 in. x 4 ft. tool lathe, one 15-in. shaper, one 28-in. vertical drill, one 16-in. sensitive drill, one universal milling machine, one combined punch and shear, one double-wheel emery grinder, one grindstone, one blacksmith's forge, vises, etc. All tools will be driven by electric motors.

The refrigerating plant is in duplicate, located on berth deck and has an aggregate capacity of two tons per day. An air compressor of 50 ft. per minute capacity is supplied for furnishing air for pneumatic tools and for blowing boiler tubes.

The general construction of the hull is clearly shown in the illustrations as well as the method of handling coal, either to the ship's bunkers or to other vessels.

Working all hatches it is estimated that coal can be transferred at the rate of 100 tons per hour.

The Vestal was launched May 19, 1908, but has not yet had her dock trials, although reported 98.6 per cent completed for several months past, and her steering gear and much of her equipment were incomplete Sept. 1.

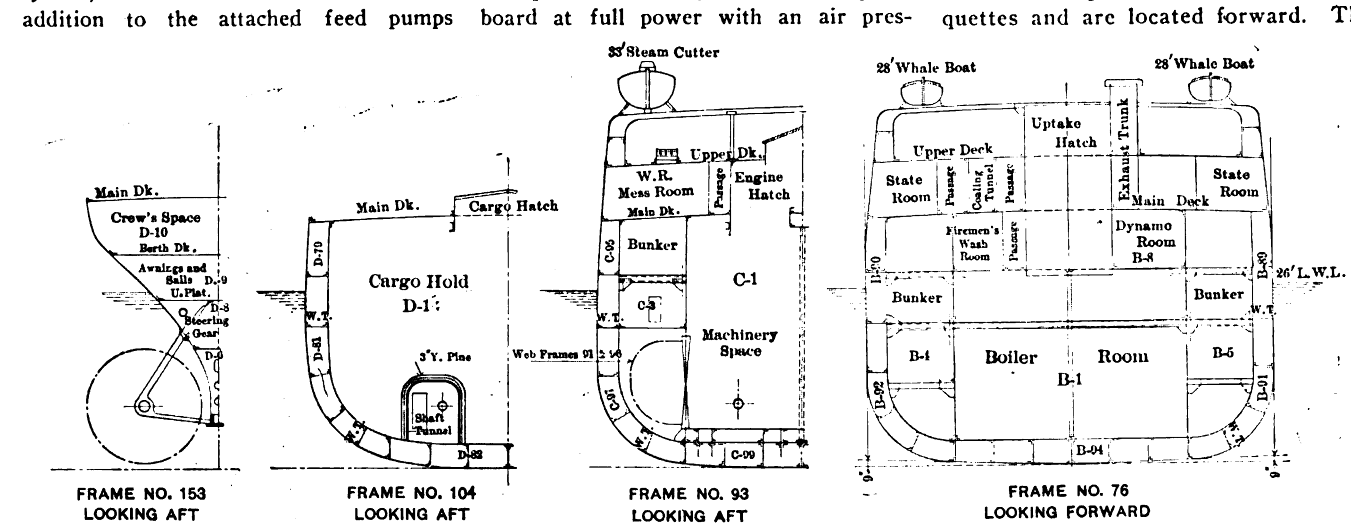


FIG. 4—SECTIONS. VESTAL AND PROMETHEUS.

SUCTION GAS PRODUCER BOAT.

A suction-gas producer boat has been put in service on the Rhine, according to the London *Times*. It is 65½ ft. long, 21¼ ft. wide and draws nearly 5 ft. with 10 tons of fuel on board. The producers use lignite briquettes and are located forward. The gas holder and two four-cylinder 200-H. P. engines are amidships, and the crew's quarters are aft. Each engine drives a propeller shaft carrying two screws, the blades of which can be reversed by gearing controlled from the engine room. About 1.1 lb. of fuel per H. P.-hour is used.

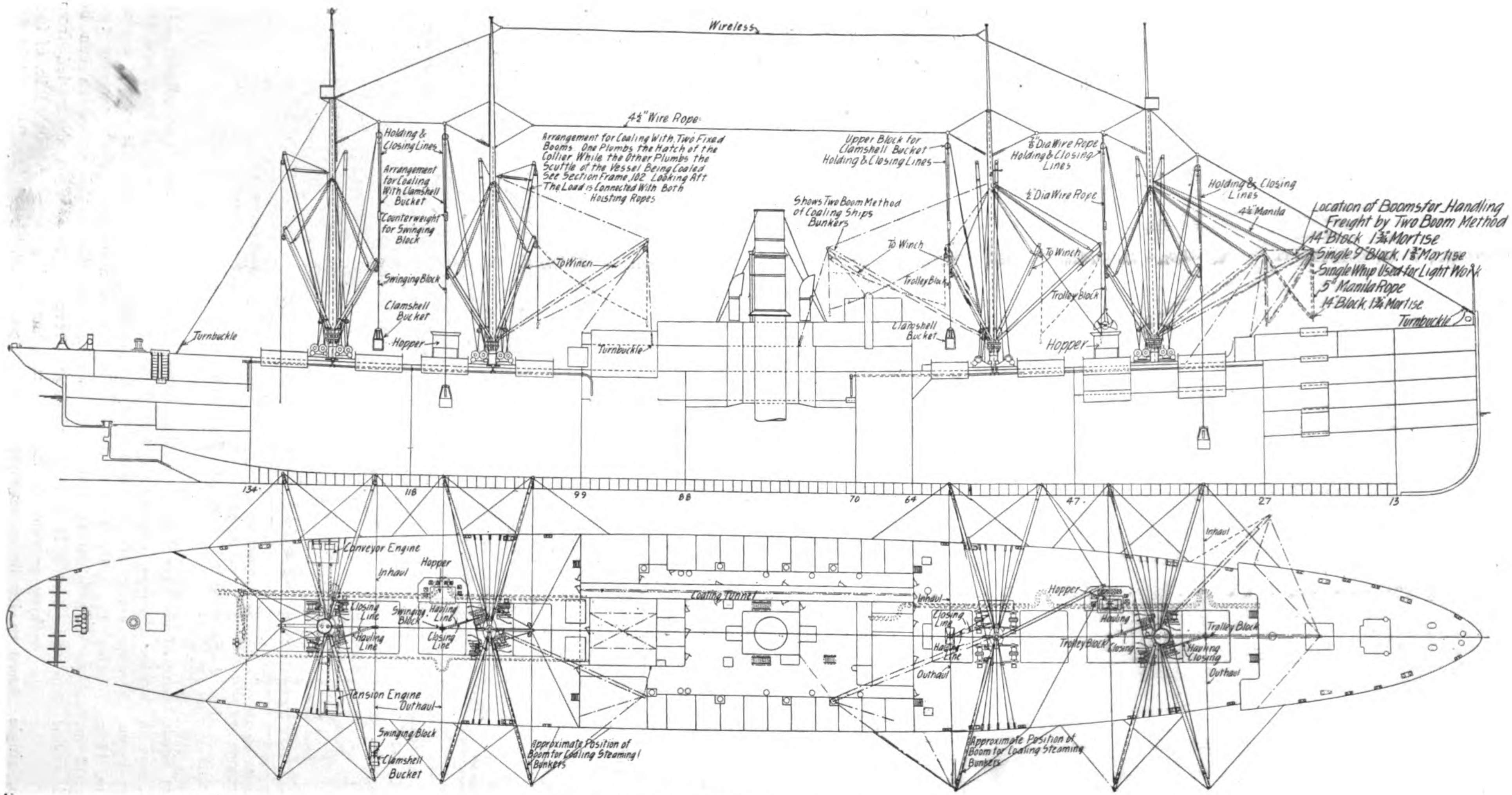


FIG. 5—RIGGING PLANS. CARGO HANDLING GEAR.

1. Leads for Lidgerwood Winches.—(a) Lead from front drum, crank end, of hoisting winch, i. e., winch on an angle, through upper block supporting clamshell bucket through trolley block to frame of bucket. (b) Lead from rear drum of hoisting winch through upper block supporting clamshell bucket through trolley block to sheave on bucket. (c) Lead wire rope from support of trolley block through block under upper block supporting clamshell bucket, to counterweight. (d) Lead from front drum, crank end, of swinging winch, i. e., winch parallel to center line of ship, through leading block on band on boom to block on end of boom on opposite side of ship from that on which the winch is located, then to the trolley block shackle, and secure. (e) Lead from rear drum of swinging winch through leading block on pad eye on boom to block on end of boom on same side of ship as winch, then to trolley block shackle and secure.
2. Two Boom Method for Lidgerwood Winches.—(a) Lead from forward drum, crank end, through leading block on boom when necessary, through block on end of boom to the left of the operator, to the overhauling weight. (b) Lead from rear drum, through leading block on boom, when necessary, through block on end of boom to the right of the operator, to the overhauling weight.
3. Leads for Norfolk Winches Operating Clamshell Bucket.—(a) Lead from port drum, on port winch, through leading block on boom, to upper block supporting clamshell bucket through trolley block to top of bucket and secure. (b) Lead from starboard drum on port winch, through leading block on boom to upper block supporting clamshell bucket through trolley block to sheave on bucket and secure. (c) Counter weight rigged the same in all cases. (d) Lead from port drum of starboard winch through leading block on boom to block on end of port boom, then to trolley block shackle and secure. (e) Lead from starboard drum of starboard winch through leading block, to block on end of starboard boom, then to trolley block, shackle and secure.
4. Two Boom Method for Norfolk Winch.—(a) Lead from right hand drum through leading block on boom, through block on end of boom to the right of the operator, then to overhauling weight and secure. (b) Lead from left hand drum, through leading block on boom through block on end of boom to the left of the operator, then to the overhauling weight and secure.

Lead for Coaling Boom Topping Lift.—Hauling part leads to a 14-in. swivel block on deck near mast and then to nearest gypsy head. When the boom is in position stopper from throat of block, and belay to cleat on mast, leaving the rope in the above named block.

Scheme for coaling steaming bunkers, shown in broken lines, except where the booms, etc., coincide with coaling arrangement, coals one side at a time. Port side rigged similarly. Both sides can be coaled at the same time by using the two outboard booms on each mast at 55½ and 108½. The after boom on mast at frame 55½ is swung inboard, over the coaling scuttles, and the forward boom swung outward, similar to the starboard side. This is done by unshipping the boom to get it aft of the rigging and then putting the socket in place. A similar arrangement is made at 108½.

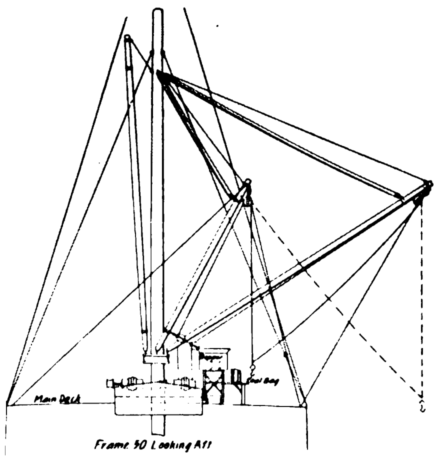


FIG. 6—METHOD OF FILLING AND TRANSFERRING IN BAGS.

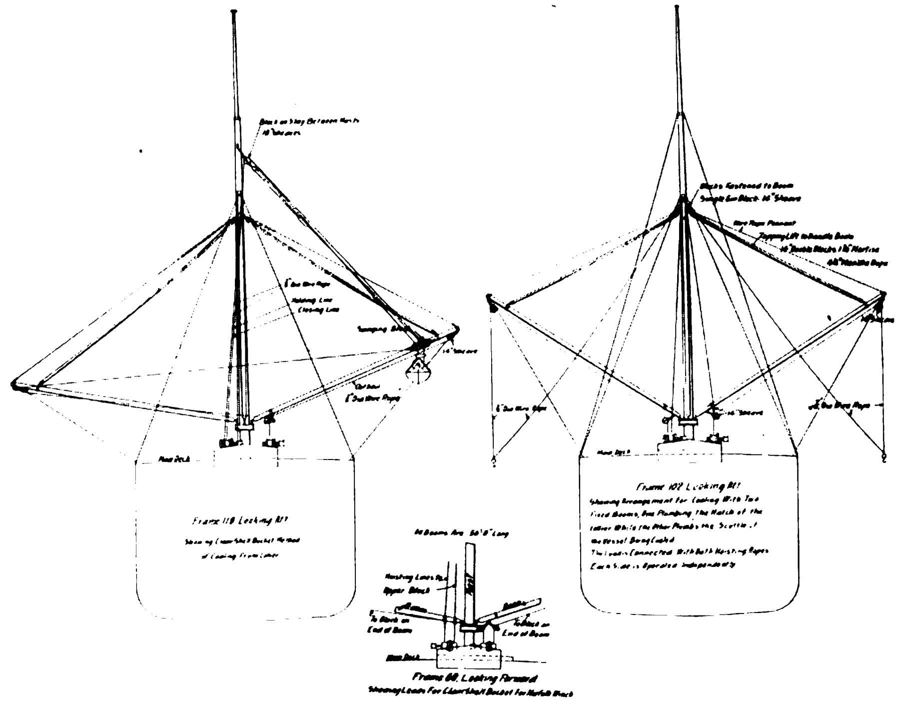


FIG. 7—METHOD OF TRANSFERRING BY CLAMSHELL BUCKET.

I. PENDULUM ARRANGEMENT. (1) The booms are arranged as shown on Section 118. The use of clamshell buckets of one ton capacity is contemplated, employing two ropes and a device for swinging the bucket after the coal is hoisted from the hatches. The center boom over the hatch out of which the coal is taken is stowed vertically out of the way. The ropes are led from a two-drum winch directly to a two-sheave block, secured to a stay between masts, thence the ropes lead down through the swinging block to the clamshell bucket. A second winch having two drums, operates a swinging block, a pendulum rope holds this block in suspension and because of the great elevation of the stay supporting the pendulum rope, the swinging block travels in a flat arc. (2) Bags filled by hand in the hold can be transported by this arrangement by using a hook instead of the clamshell bucket, and fastening the bags to it.

II. TWO-BOOM ARRANGEMENT. The booms are rigged, as shown on Section frame 102, one boom is guyed so that its point plumbs the hatch of the collier while the point of the other plumbs the scuttle on the vessel being coaled. One winch with two drums is used; a rope from each drum leads to the load through a block on the end of each boom. One drum hoists while the other pays out, being controlled by a friction band.

III. BAGS FILLED BY CLAMSHELLS. The pendulum rope and clamshell bucket is used to fill the hopper and from it the bags are filled. They are then transported by the two-boom arrangement described in paragraph II. See Section frame 50.

IV. The maximum load of coal which can be handled by the clamshell bucket is 2,240 lb., and by the two-boom method is 6,240 lb., including the weight of the bags.

The Point of View

An Instance of the Influence Upon Opinion of Association and Environment.

IT is the all but universal custom among English technical and trade journals to make a parade of the exercise of extreme caution and reserve in quoting from American sources and to take the stand that anything that is worth having or knowing, particularly in things nautical, must needs originate "at home," or, if not, the value of new devices is not established until passed upon by British opinion. Doubtless this attitude is in part due to the sensational and inaccurate non-technical press and the absurdities for which it is responsible, but it is equally due to British complacency and conservatism.

In a recent issue *The Shipping World*, London, reporting the summer meeting of the American Society of Naval Architects and Marine Engineers, at Detroit, mentions the fact that the members had an opportunity of seeing the steamer J. Q. Riddle, which went to sea loaded with 10,000 tons of coal in 45 days from the laying of the keel, and says: "Such vessels are, of course, but glorified barges." There is no particular reason for objecting to the title, if it pleases our cousins to use it; the term barge is in itself indefinite enough to cover almost any case, and the reader can for himself compare the steamer referred to, and of which we present an indifferent illustration, with the type of barge with which he happens to be most familiar.

The distinguishing features are of course the machinery placed clear aft and the unobstructed deck common to all bulk freighters on the great lakes.

We will now take a look at a contrast and present the following, also from *The Shipping World*:

On Friday, July 30, the fine steel screw steamer Victor Hugo, built by Sir Raylton Dixon & Co., Ltd., of Cleveland dockyards, Middlesbrough-on-Tees, and constructed on their well-known patent cantilever framed system, with topside water-ballast tanks, to the order of Messrs. Delmas Freres, of La Rochelle, proceeded to sea for her official trials. The vessel has been built to Lloyds highest class under special survey, and to comply with French law requirements, with engines aft. Her leading dimensions are 301 ft. by 43 ft. by 21 ft. 4 in., and she will carry over 3,700 tons on 18 ft. 4½ in. draught, with a net register of 1,230 tons. The ship thus carries over three times her net register tonnage. Water ballast capacity is 1,165 tons, of which 485 is carried in the topside tanks under the deck. The holds are perfectly self-trimming and free from all obstructions such as beams, pillars, or web frames. She has four holds and four large hatchways 25 ft. wide, the longest of which is 35 ft. 5 in. A notable feature is that all the hatchways are covered with portable steel covers which are easily removed in five lifts by the derricks and require no tarpaulins. The vessel has two masts, four derricks, five steam winches, steam windlass, steam steering gear, and all the latest appliances for the rapid handling of cargo. Triple-expansion engines, placed aft, having cylinders 22, 35 and 59 by 39 stroke, with two large single-ended boilers, working at 180 lb. pressure, have been fitted by Messrs. Richardsons, Westgarth & Co., Ltd., of Middlesbrough.

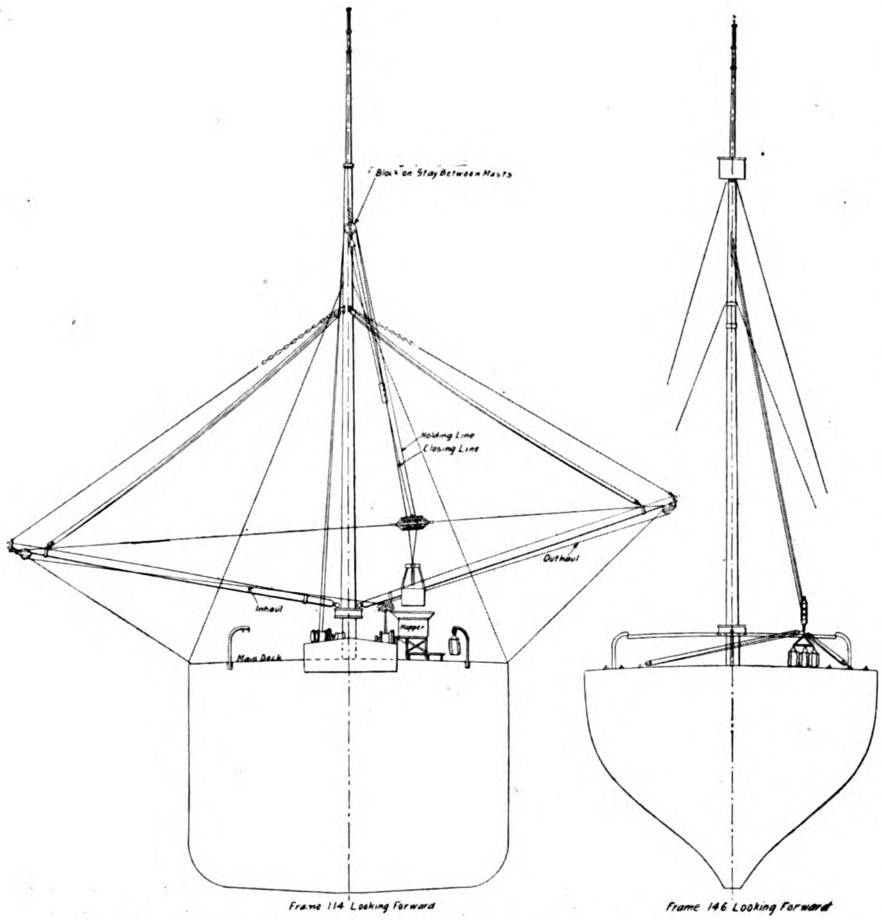


FIG. 8—METHOD OF TRANSFERRING BY CLAMSHELL AND BAGS.

Coal is taken from the hold of the collier by the use of one ton clam-shell buckets, using the pendulum rope arrangement indicated, for bringing the bucket over the receiving hopper, one of which is provided for the forward hatches, and one for the after hatches. The clamshells will probably deliver about one ton each trip, and average three trips in two minutes.

At the hoppers the coal is loaded into 200-lb. bags, the use of bags being considered necessary in order to facilitate the distribution of coal on the war vessel, in the wake of each hopper a train of trolleys is waiting. The bags are hooked onto these trolleys and pushed off the hopper platform until all the trolleys are loaded, making a load of 18 bags or 3,600 lb.

After being loaded, the train of trolleys is hauled to the assembly point, fr. 142, by a line from a drum, on one of the after winches, a tail rope being overhauled at the same time from a smaller drum on one of the forward winches. These drums being so proportioned as to give the rope a speed of about 600 ft. per minute.

Three trains of trolleys are worked at once. No. 1 for instance is being loaded on the port side forward. No. 2 has just been unloaded and is waiting on the cross over track for No. 1 to pass the switch, when the hauling lines will be transferred to No. 2 and it will be hauled forward, to be loaded. No. 3 has meanwwhile been loaded on the starboard track aft, and is probably now being unloaded at the platform. It will be pushed back again to where it was loaded probably by hand just before No. 1 arrives at the platform.

In addition to the clamshell method of working, which makes use of only two of the hatches at one time, bags may be filled by hand in any of the other hatches hoisted out and hooked onto single trolleys which then can be pushed by hand to the after platform or added to one of the trains. It is estimated that two tons per minute can be delivered by this method (trolley system).

At the assembly point, frame 146-142, a reserved supply of filled bags should be maintained. The bags are assembled there in groups of twelve, one to port and the other to starboard and are transferred alternately to the main cableway, so that one group is being assembled while the other is being hooked onto the carrier. A special carrier made to convey 12 bags (at least) and so arranged that they can be quickly hooked on and released, is intended to be employed.

Two hauling down tackles are connected to the cable-way. The arrangement is such that a load can be picked up from any point across the deck.

The several winches operating the cable-way are all located well aft so that the operators are all in full view of the men at the winches.

AVERAGE CAPACITY OF TROLLEY SYSTEM.

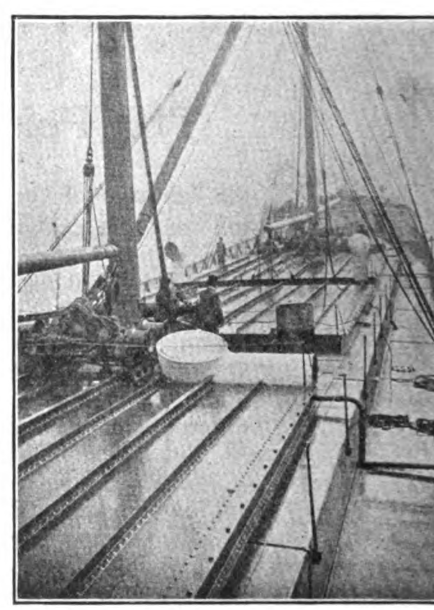
1 train of 6 trolleys or 18 bags from forward hatches every 2 minutes	3,600 lb.
1 train of 6 trolleys or 18 bags from after hatches every 2 minutes	3,600 lb.
4 bags per minute filled in after holds by hand or 8 bags every 2 minutes	1.600 lb.
Total in 2 minutes	8,800 lb.
Total in 1 minute	4,400 lb.
Total in 1 minute	2 tons.
Probable maximum capacity of marine cable way in 1 minute	1 ton.

It is to be regretted that we are unable to present a good view of the "fine steel screw steamer," but we have reproduced from *Shipping World* a deck view looking forward, from which it will be at once seen that besides the machinery the pilot house and bridge are also aft, as in the ancient type of lumber hookers now almost extinct on the lakes. Verily, the difference between fine screw steamer and glorified barge is mostly geographical.

For 40 years the British builder, and some on our own Atlantic coast, could scarcely find words to express their scorn and abhorrence of the things built on the great lakes. To call them ships was to profane the sanctuary. That they could serve any useful purpose and that any could be so daredevilish as to leave port in them was one of those things the reason for which no fellow could find out. To put machinery in the stern was idiotic. Even a prominent lake builder at one time, following upon the disappearance of a couple of ships which were supposed to have broken in two, became so badly rattled that he announced that hereafter his ships would be built with machinery amidships, and in fact he did actually so build two.

Since that time, however, they have not only had their machinery shifted aft, but have both been lengthened 72 ft. But the lake ship has been the most successful carrier in the whole world and now the bulk carrier and the tanker of all countries are following in its wake.

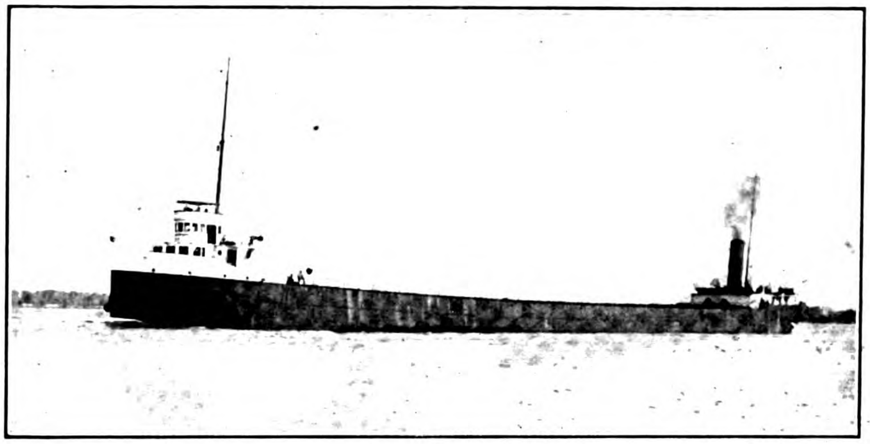
The unobstructed hold, without beams or stanchions, was a feature of lake ships years and years ago. The wide hatches have always been a feature, though declaimed against as weakening



"CANTILEVER" FRAMED STEAMER VICTOR HUGO; DECK VIEW SHOWING TRUNK AND STEEL HATCH COVERS.

the ship. There are, however, no lake ships without a deck beam for 35 ft. of length, a feature much more open to question than the width of hatch.

The "notable feature" of portable steel hatch covers lifted by cranes was abandoned 10 years since.



Bulk Freighter J. Q. Riddle.

Steel hatch covers are still employed, but they are of the telescopic type and opened and closed singly or in groups by machinery. In the matter of equipment no cargo ships in the world compare with the once despised "laker." There is no improvement in steam steerers, windlasses, winches, electric lighting, ballast handling, etc., which they are without.

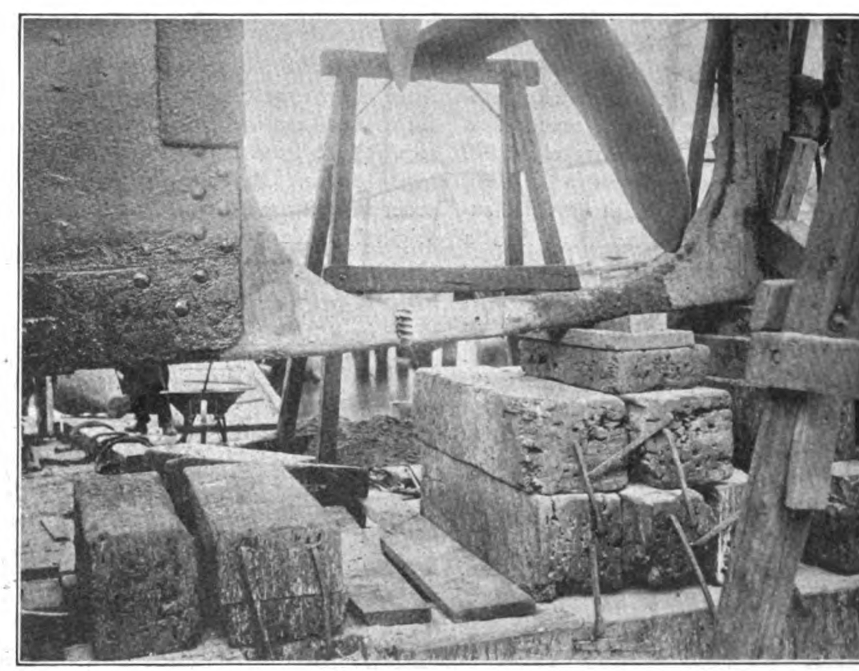
In the matter of handling water ballast alone there are no ships in the same class. Where 10,000 tons of cargo is put aboard in two or three hours from making port, 3,000 or 4,000 tons of water must be disposed of with celerity. And in the matter of finish, space and convenience of accommodations they are absolutely unique, if the term can be applied in the plural sense.

The "glorified barge" makes no contemptible showing alongside any cargo ship anywhere, and those who think they lack something in strength and seaworthiness, have never lived out a winter gale on Lake Superior. Ships have come to the lakes from other parts of the world, even from the Clyde and the northeast coast and have made no better showing in Lake Superior weather; they have even disappeared and left no trace of ship or crew, and they were not built after lake models either, but after the tried and true good old tramp type. The average sea-going master would not for any consideration venture to sea in light trim except on an even keel, and in a bit of sea his propeller is fanning air a large share of the time, while the modern type with machinery aft and liberal water ballast will go along comfortably and make good headway. Some day the ocean-going bulk freighter will develop to the standard now existing on the lakes, and when that time comes the builders of the lakes will have set the goal still further ahead.

RECENT MARINE REPAIRS BY THE THERMIT PROCESS.

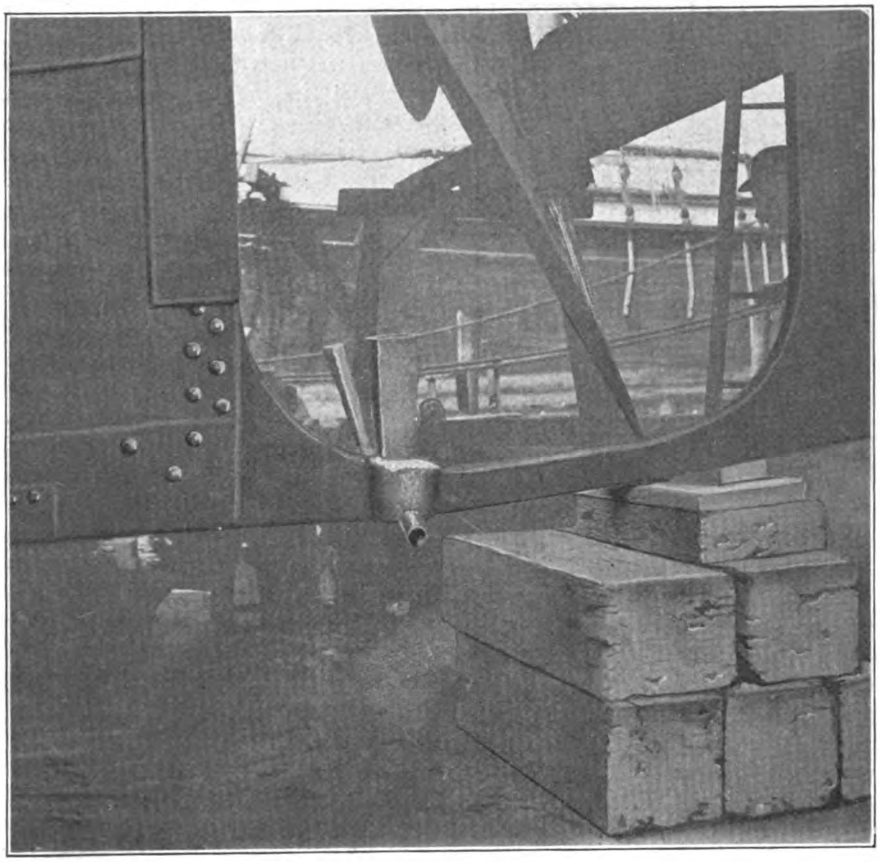
The Thermit process has been utilized for some important steamship repairs within the last few months, more especially in the welding of stern posts and rudder stocks. The largest repair of this kind which has been made in some time was carried out for the Clyde Line at the dry docks of Tietjen & Lang, Hoboken, N. J., on the steamship Arapahoe, a vessel of 4,000 gross tons. The repair consisted in welding the stern frame of the vessel, which was broken about 24 in. aft of the stern post, the section at the fracture being about 7 x 9 in. in area. In making this repair, the fracture was drilled out to provide a space of about 1½ in. for a free flow of Thermit steel, and a mold box was then placed in position and packed with sand, space being provided for a collar surrounding the broken sections and for a pouring gate and riser. Yellow wax was used as a pattern and the molding materials consisted of one-third fire clay, one third ground fire brick and one-third sand was packed around this as a matrix. Wooden patterns were used for the gate, riser and small preheating hole in the bottom of the mold.

In making Thermit welds it is necessary to bring the sections to be welded to a red heat so that when the super-heated Thermit steel produced by the reaction between the aluminum and iron oxide, is poured into the mold it will melt up the ends of the pieces to be welded together and unite with them to form a homogeneous mass when cooled. The fact that these welds may be made without removing the broken parts from the ship effects a marked saving in both time and expense. In the case of the Arapahoe the vessel went into dry dock at 7:30 in the morning and by 6 p. m. the next day was ready for service—the total time consumed in making the complete repair being only 35 hours.



Fracture Opened by Drilling Ready for Placing Mold.

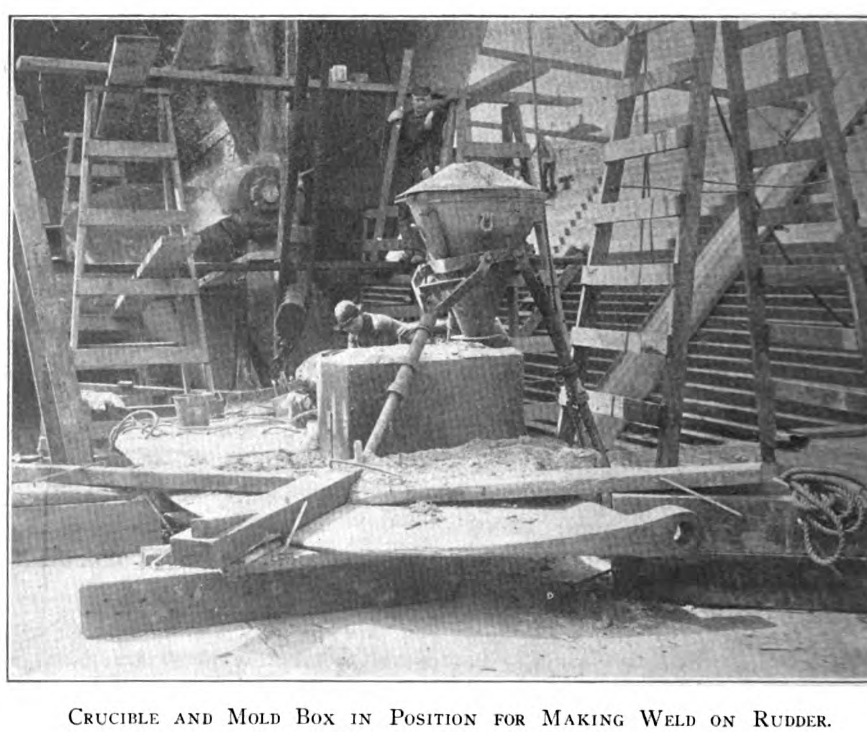
To those unfamiliar with the use of Thermit for this work, it might be well to explain that Thermit consists of a mixture of finely divided aluminum and iron oxide, which may be ignited by means of special ignition powder. The chemical reaction so produced causes the aluminum to combine with the oxygen in the iron



VIEW AFTER REMOVING MOLD AND BEFORE CUTTING OFF GATE AND RISER.

oxide and set the iron free. The temperature produced by the reaction is very great, being approximately 5,000 deg. Fahr. It may readily be seen, therefore, that by allowing this superheated liquid iron to flow into a mold surrounding the ends of the sections to be welded together, it will amalgamate with them to form a perfectly solid piece when cooled. In order that best results may be obtained it is necessary to bring the sections to be welded to a bright red heat before pouring the Thermit steel, as better amalgamation is thus obtained and the weld will be solid and free from blow holes or other defects.

The process has been extensively used in marine repairs, not only for the welding of stern frames, but also for crank shafts and rudder stocks. An interesting repair of the latter sort was carried out at Wilmington, Del., at the yards of Messrs. Harlan & Hollingsworth, on the rudder of the steamship Toledo, belonging to the Sun Company, Philadelphia. The rudder in question consisted of a single steel casting, and its repair would have been entirely out of the question if it were not for the Thermit process, owing to the fact that the stock and part of the cheek of the rudder were cracked and it would have been necessary to make an entire new casting, which would have required at least two weeks, and perhaps longer. By using the Thermit process of welding, however, the original rudder was repaired and the entire operation finished in the remarkably short time of 43 hours from receipt of order. The repair was carried out in essentially the same manner as described for welding the stern post of the Arapahoe, and the accompanying illustrations show the various stages of the operation.



CRUCIBLE AND MOLD BOX IN POSITION FOR MAKING WELD ON RUDDER.

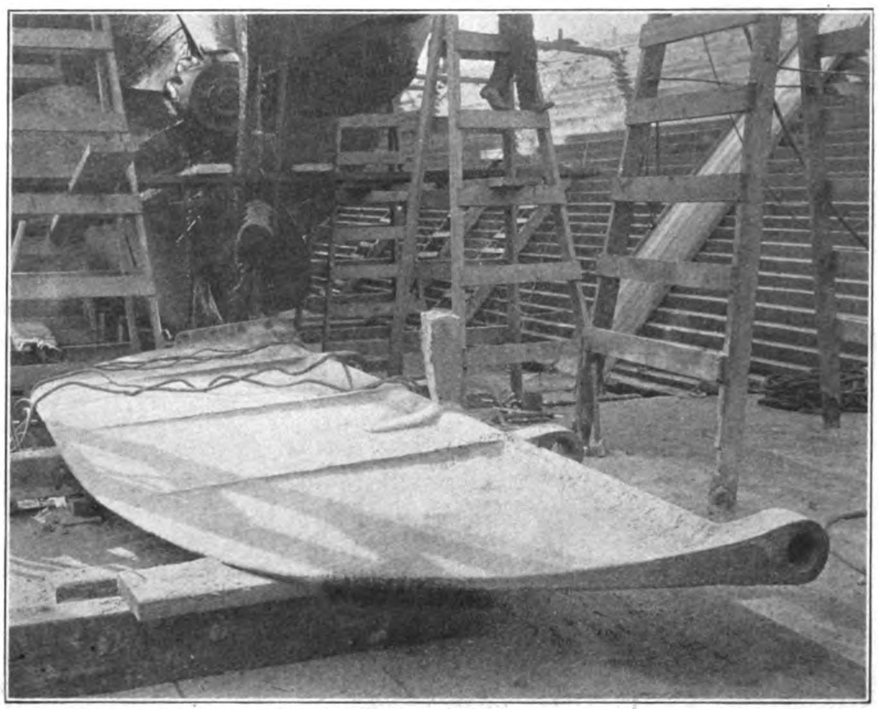
WRECK OF STEAMSHIP OHIO.

The Alaska Steamship Co.'s liner Ohio, was wrecked on a submerged rock in Finlayson channel, near Carter's Bay, British Columbia, about 2:00 A. M. Thursday, Aug. 26. The night was densely black and rainy. The Ohio was proceeding at moderate speed when she struck on the port bow, badly wrecking her forward compartments. She was immediately backed off the rocks and beached in Carter's bay, where she sank in six fathoms of water about 45 minutes after striking the reef.

In the interval all but five of the passengers and crew were landed in safety. Among those who lost their lives was Geo. C. Eccles, wireless telegraph operator of the Ohio. Eccles stayed by the ship to the last in an unsuccessful effort to secure assistance by means of the wireless.

The passenger list included 79 first class and 61 steerage passengers. The Ohio was in command of Capt. John Johnson. Other officers of the crew were Capt. R. B. Snow, pilot; R. B. Cockran, first officer; E. Stuart, second officer; E. Raymond, chief engineer, and C. Dybdal, second assistant engineer.

The Ohio was a steel ship built in 1873 at Cramp's yard in Philadelphia.



FINISHED WELD, SHOWING METAL LEFT IN RISER.

She was 343 ft. in length, 43 ft. beam and 24.9 ft. deep. She registered 3,488 gross and 2,072 net tons. Her loaded draught was 22 ft. and her speed 13 knots. She had accommodations for 175 first class and 490 steerage passengers.

It has not yet been determined whether it will be practical to raise the vessel or not.

The disaster emphasizes the necessity for a thorough survey of the inside passage between Puget Sound and Alaska and the preparation of accurate charts showing all obstructions to navigation dangerous to vessels drawing up to 25 ft. The channel has not been surveyed for years, and it was only a few years ago that it was thought to be unsafe for vessels drawing more than 10 ft.

New Japanese Steamer Tacoma Maru

BY H. COLE ESTEP.

WHEN the Chicago, Milwaukee & St. Paul Railway Co. decided to extend its lines to the Pacific coast, negotiations were opened for the establishment of a new line of trans-Pacific steamships which would connect the Orient with the railway's Pacific coast terminals. The result was, the Osaka Shosen Kaisha, a Japanese corporation which in the scope of its plans, aims to soon rival the older Nippon Yusen Kaisha, operated in connection with the Great Northern railway. At present the Osaka Shosen Kaisha's American line comprises two vessels, the Seattle Maru and the Tacoma Maru, operating regularly between Puget Sound and Oriental ports in connection with the Chicago, Milwaukee & Puget Sound railway. The service was inaugurated by the Tacoma Maru which sailed from Puget Sound on her first westbound voyage on Aug. 21.

The two steamers are practically sister ships. Except for a few auxiliaries they were built completely in Japan. Most of the steel plate and structural shapes used in the construction of the vessel were rolled in Europe. While the new liners are primarily cargo carriers they also have limited passenger accommodations.

The vessels were built by the Kawasaki Dock Yard, Kobe, Japan.

The Tacoma Maru, which the writer had the privilege of inspecting, is 419 ft. in length, 49 ft. 6 in. beam and 29.95 ft. in depth. Her gross tonnage is 6,178. She is built strictly according to Lloyds specifications and is a first class modern vessel in every respect. The Tacoma Maru has six cargo hatches and eight steam cargo winches, which were designed and built by the Kawasaki Dock Yard.

She has accommodation for six first class passengers and 178 steerage passengers.

Her propelling machinery consists of twin screw, three-cylinder, triple-expansion engines of 2,400 indicated horsepower each. The high, intermediate and low pressure cylinders are 9½, 32¾ and 55 in. in diameter respectively, with a common stroke of 46 in. The high pressure cylinder is fitted with piston valves, while the intermediate and low pressure cylinders each have double-ported balanced slide valves. The general design of the engines indicates English rather than American influence.

A noteworthy and commendable feature of the vessel is her roomy engine room. It occupies the full width of the ship and a distance fore and aft of about 45 ft. The engines are thus made very accessible; each cylinder and valve chest is separated from its neighbor by a distance of about 2 ft., instead of all three cylinders and valve chests being placed as close together as possible. While this design takes up from 6 to 8 ft. more space fore-and-aft than is absolutely necessary and possibly adds a little to the condensation losses, it certainly does make the engine much more accessible and the engine room less cramped than on the average vessel.

At 75 revolutions per minute and 200 lb. boiler pressure the speed of the ship is 12 knots an hour; her maximum speed is 15 knots.

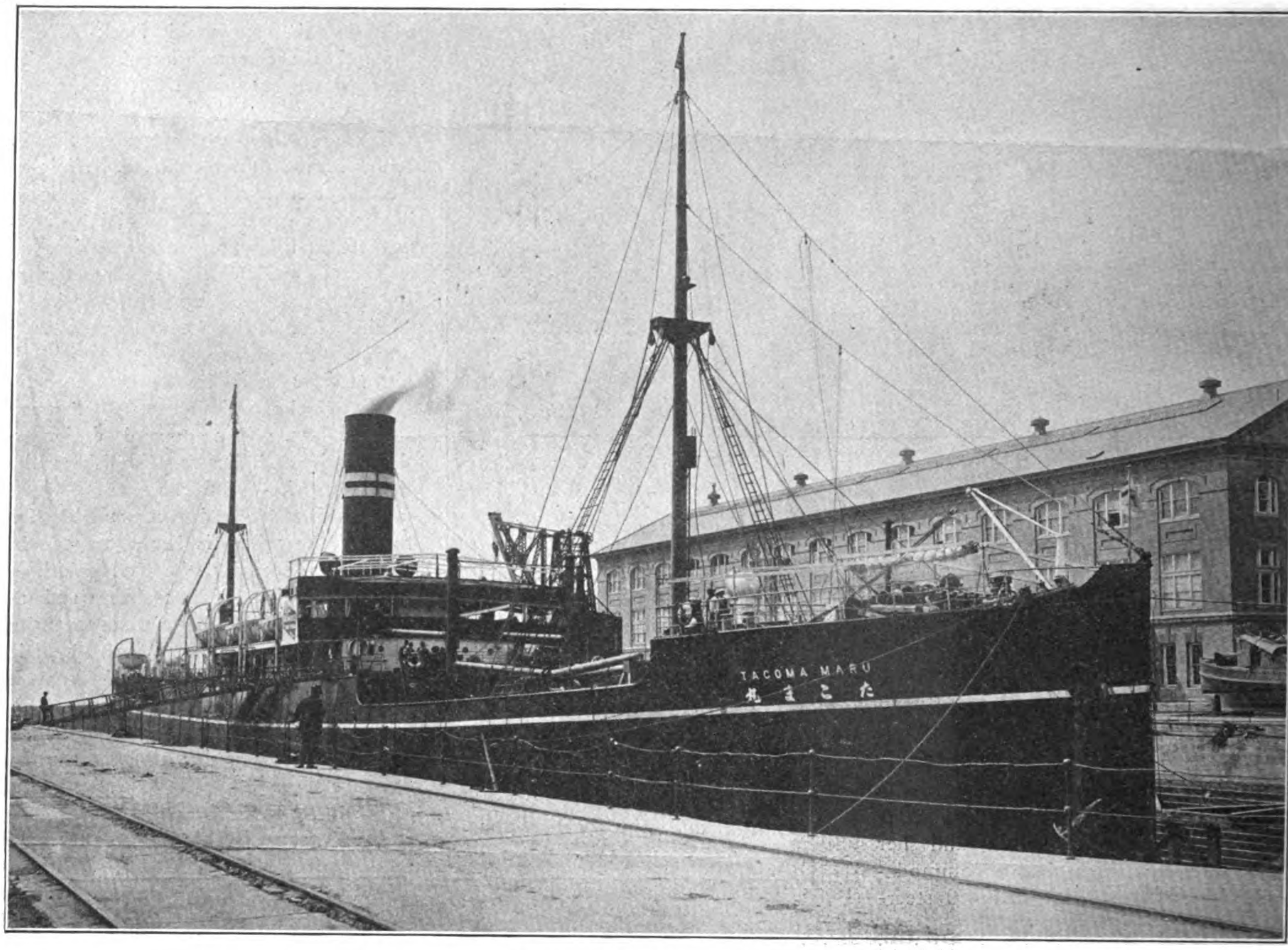
There are three three-furnace single-ended boilers of the Scotch marine type, each carrying 200 lb. per sq. in. steam pressure. The boilers are 15 ft. 6 in. in diameter and 11 ft. 6 in. in length. The Howden forced draft system is used. The bunkers have a capacity of 3,200 long tons. Japanese coal, costing 5 yen ($2.60) a long ton f. o. b. ship, is used for fuel.

The two propellers are each 15 ft. 6 in. in diameter, with a pitch varying from 17 ft. 3 in. minimum to 18 ft. maximum. There are four blades on each propeller and four spare blades are carried on board.

The steering engine and a few minor auxiliaries were built by Caldwell & Co., Glasgow, Scotland.

The normal time of the ship between Yokohama and Tacoma, Wash., is 15 days and 2 hours.

The Tacoma Maru carries a crew of 60 men and 23 officers. The vessel is in command of Capt H. Yamamoto, and T. Show is chief engineer. The



S. S. TACOMA MARU IN DRY DOCK AT BREMERTON, WASH.

entire crew, from the master down to the coal passers and cabin boys, is Japanese.

The Tacoma Maru is in every way a credit to the rapidly growing merchant fleet that flies the red sun flag of Japan.

TUG FOR PORT OF PORTLAND.

The Port of Portland, Portland, Ore., has advertised for bids for an additional steel bar-tug for Columbia river towing service.

The new vessel will be built of steel according to approved specifications and with the following principal dimensions: Length over all, 116 ft.; beam molded, 25 ft.; depth, molded, 15 ft.; draught, aft, 12 ft. 6 in.; draught, forward, 10 ft. 3 in.

The tug will be provided with a compound condensing engine, 20 in. and 44 in. in diameter by 28 in. stroke, two Scotch marine boilers, 10 ft. 6 in. in diameter by 11 ft. long and designed to carry a maximum pressure of 170 lb. per. sq. in. Oil will be used for fuel.

The new vessel was designed by C. H. Norrlin, consulting engineer, Portland, Ore.

PLANING PROPELLERS.

The ordinary cast propeller, either of the solid or sectional type, is usually far from being a true helix and the degree of variation differs at all points.

True pitch propellers might be corrected by an amplification of the ordinary screw cutting methods, but those of expanding or differential pitches cannot be so treated. In all, however, except some extreme types such as the Hirsch, and whether the blades are raked or not, the surface lying along any radius is a straight line, and it is thus possible to produce a true helix by planing so long as the relative advance of tool and surface are correctly timed. As a geometrically correct surface is manifestly more efficient than an imperfect surface, many attempts and devices have been made to produce it and the illustrations show a very successful adaptation at the works of the Fore River Shipbuilding Co., Quincy, Mass.

In general arrangement of movements it does not, of course, differ much from others, but it is interesting as an example of adapting already existing equipment to special uses without destroying its usefulness for other purposes. A machine especially built for dealing with propellers up to large sizes would be extremely costly; in fact the annual charges on such a tool would probably pay for doing most of the planing actually required with the means here employed.

In this case a small planer is employed merely to carry the tool and operate the feeds and the propeller is mounted on an entirely distinct and comparatively inexpensive base, the platen of which can be tilted as in Fig. 1 to correspond with ordinary rake angles and carries a worm-operated turn table on which the propeller is centered by the arbor shown. Fig. 2 shows the apparatus operating on a small propeller with little or no rake.

The worm rotating gear operates with the table at any angle through the telescopic shaft and universal couplings as seen in Fig. 3. As the vertical feed of the tool and the rotary feed of the propeller must be simultaneous, both are derived from

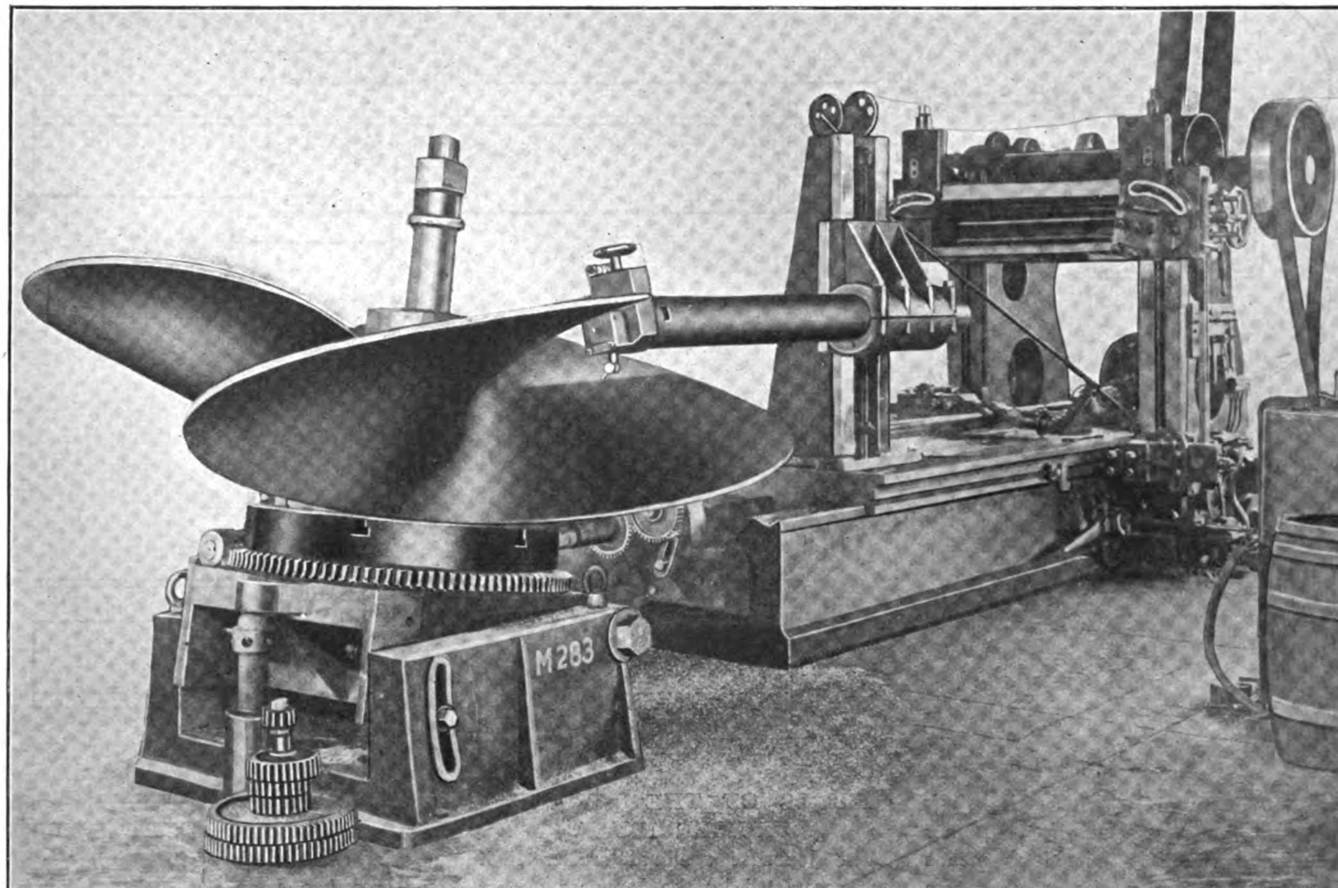


FIG. 1—PROPELLER PLANING MACHINE OPERATING ON PROPELLER WITH RAKING BLADES.

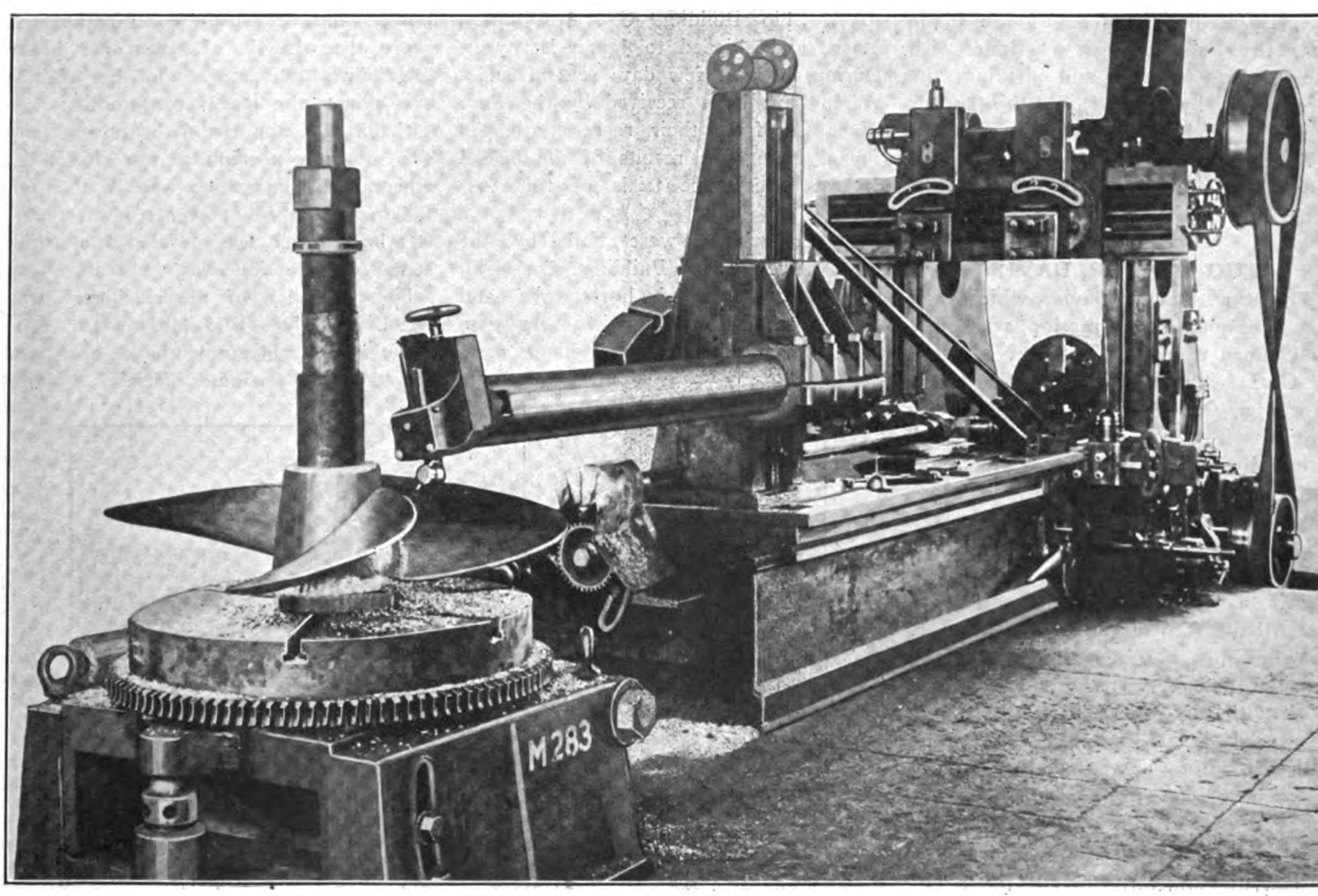


FIG. 2—PLANING SMALL PROPELLER, AXIS PERPENDICULAR.

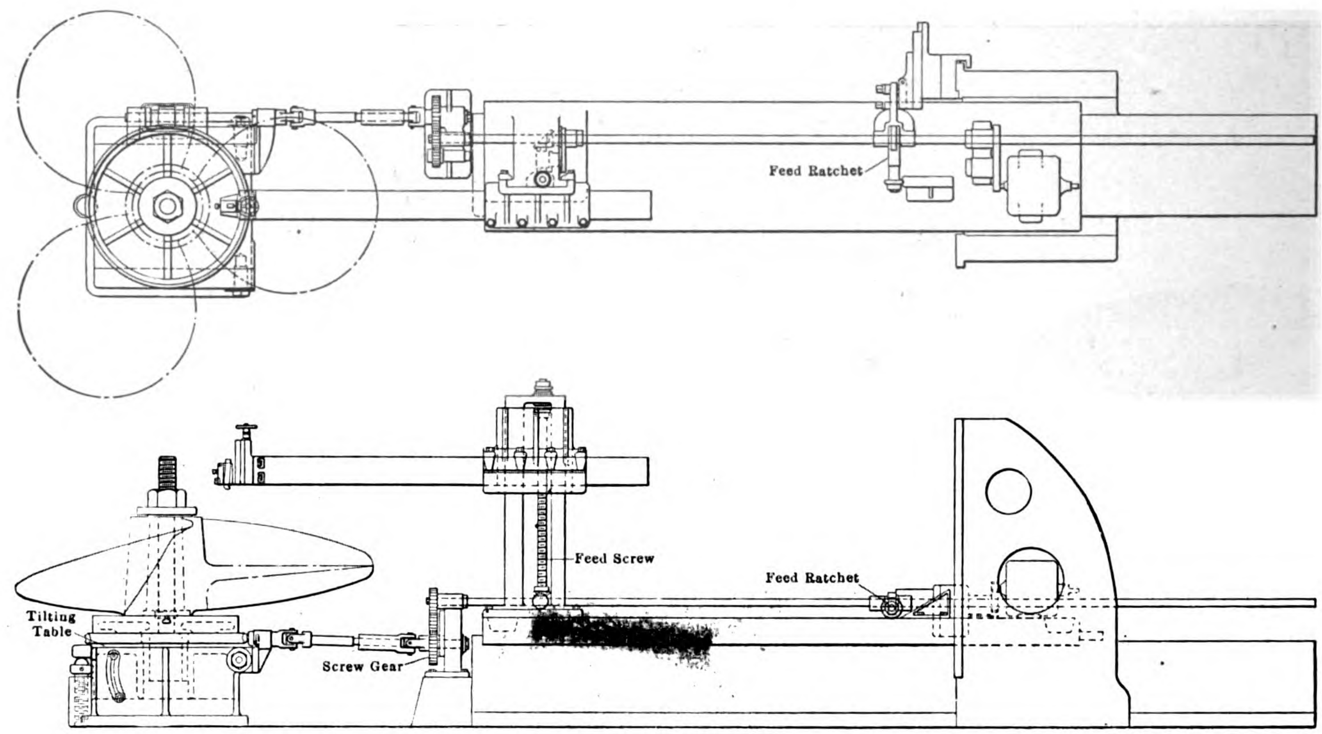


FIG. 3—PLAN AND ELEVATION OF PROPELLER PLANING MACHINE.

a common source, which is the shaft seen running lengthwise of the planer platen, and which is shifted by means of a ratchet riding the cam shown most clearly in Fig. 3.

Before planing is actually begun, a clearance groove, with depth at finish line, is cut in the face of the blade near the hub and this is done with the platen at rest and driving the feed gear by means of the motor shown geared to feed shaft.

By means of change gears propellers of different pitches may be dealt with.

TUG ULSTER DAVIS.

The tug Ulster Davis, which has just been put in commission, was built by Osborn & Sons, Croton, N. Y., for R. G. Davis, 454 Forty-eighth street, Brooklyn, N. Y. The tug is 55 ft. long, 16 ft. beam and 5 ft. deep and is supplied with a Taylor water tube boiler, built for 200 lb. working pressure. The engine, 12 x 16 in., was built by George H. Ward & Co., 78 Delavan street, Brooklyn, N. Y. The tug is named after the president of the Albany Towing Co., by whom it was designed, Mr. Davis having had considerable experience in shoal water work with tug boats. The Ulster Davis was designed for barge canal work with low pilot house and hinged stack to clear bridges. She is at present engaged in towing on the Champlain canal for the Lake Champlain Transportation Co., between Waterford and Whitehall.

TRIALS OF THE JAPANESE CRUISER IBUKI.

The Japanese armored cruiser Ibuki, just completed by the Japanese government, has undergone her trials. The vessel was equipped with Curtis marine reversible [illegible] built by the Fore River Ship Building Co., of Quincy, Mass., and shipped to Japan last year. During the past few days several cablegrams have been received by the Fore River Co. from their representative in Japan, giving the results of the official contract acceptance trials of this vessel.

These turbines were built by the Fore River Ship Building Co. with rigid guarantees of horsepower and steam consumption, and in every case these guarantees have been handsomely exceeded.

Three trials were conducted, one under cruising conditions at two-fifths power, one at the rated full power guaranteed and one at overload conditions at maximum power.

The rated full power of these turbines was guaranteed to be 21,600 brake horsepower, and the steam consumption not more than 15 lb. of steam per brake horsepower per hour. On the trial at this power the steam consumption was 14.1 lb. On the two-fifths power trial the steam consumption was 16.75 lb., whereas the guarantee was 17 lb. On the maximum full power trial over 27,000 horsepower was developed and the steam consumption was 13.88 lb.

The operation of the machinery was excellent under all conditions and congratulatory cablegrams have been received from Japanese officials.

TUG ULSTER DAVIS.

Transmission of Intelligence on Steam Vessels.

By H. A. Hornor, Electrical Engineer, New York Ship Building Co.

II.

TO the questions of pure electrical engineering there is augmented on naval vessels the important factor of military efficiency. Expanded this means that all apparatus must be so designed that it will be accurate and trustworthy under any and all conditions of war. That the material and instruments must withstand shocks from within when the vessel is offering her defense in action and will maintain stolidly the hot shells of her enemy in return. Development on military lines is perforce gradual when the basis of the movement revolves around the theory of battle. War is by good fortune quite rare in these "piping times of peace." But as the wise nation must prepare for war in time of peace, the development work on military lines can advance only by the observation of past naval engagements and sensible deductions from them. It might be generally stated that these interior communications divide themselves into those which are used for the ordinary peaceful movements of the vessel and those which are useful and necessary in time of actual conflict. For the purpose of being continually prepared these latter signals are always employed in drill and gun practice. With such accumulation of systems it does occur that certain ones make themselves factors in both cases to such a degree that it would appear that no taxonomy could be assumed. Such systems as the call bells, telephones and voice-tubes illustrate this clearly. These systems are just as important in battle service as in peaceful cruising. The following arrangement, though open to question, will be adopted for the purpose of this discussion:

Systems employed for both battle and cruising:*

a. Engine revolution telegraph.
b. Engine shaft revolution indicator.
c. Steering telegraph.
d. Helm angle indicator.
e. Fire-room timing.
f. Call bell.
  Exposed.
  Unexposed.
g. Voice tube.
h. Telephone.
  General.
  Engine and fire-room.
  Bridge and engine room.
  Battle.

Systems employed during cruising only:

a. Fire alarm.
b. General alarm gong.
c. Anchor handling and boat hour gong.
d. Warning signal.
e. Fuel oil tank indicator.

Systems employed during battle only:

a. Broadside ammunition hoist.
b. Broadside salvo-firing.
c. Turret salvo-firing.
d. Cease firing.
e. Gun firing.
f. Torpedo firing.
g. Gyro indicating.
h. Range and deflection.
i. Local turret gun firing indicator.
j. Turret danger zone.

It will be noted that of the systems enumerated nearly 50 per cent are devoted to the control of the guns. Later it will be brought out that besides these special systems the telephone and voice-tubes are important factors today in the naval war drama.

At the present time electric engine revolution telegraphs, steering telegraphs and helm angle indicators are designed after the "lamp pattern" type of instrument. They are identical in their method of wiring and general design, so that a description of one will suffice for all. Engine revolution telegraphs are designed for the purpose of increasing or decreasing the speed of the vessel during squadron formation.* The vessel being under orders for maintaining standard speed, this being indicated by the mechanical telegraphs, one, two, three, or four more revolutions, will be signalled by this electrical telegraph. On the bridge the transmitter of the pedestal type, by the operation of moving a handle around the circumference of the head, rings a bell and lights a lamp in the engine room, which latter signal requires the moving of a similar handle on the engine-room indicator to the revolutions desired. This done, the lamp in the transmitter is lighted, giving assurance that the signal has been received and the operation accomplished. The contact-maker in the transmitter or indicator consists simply of carbons which are revolved by the handle across insulated copper segments to complete the lamp circuits. The older type of instrument required the rapid movement of the handle of the transmitter or indicator for the purpose of operating a magneto-generator to ring the bell, but the latest design provides bells designed for 125 volts, the standard used in the United States navy.

In like manner steering telegraphs* of the pedestal and bulkhead type are installed on the bridge, in the steering-engine room, and central station for giving signals, usually in degrees, for the proper maneuvering of the vessel.

Helm Indicators.

The helm indicators are built on the same lines, are located in the same places, and are for purposes of signalling the number of degrees the helm makes when the rudder has been actually moved from the midship line. The indicators are all wired in parallel with the transmitters, but are so arranged with cut-out switches that only those indicators desired may be in service. The transmitter is located near the rudder stock and the contact arm directly attached thereto. Carbon brushes move over insulated segments of copper, which are designed in accordance with the mechanical arc through which the rudder moves. The vital parts of these instruments are enclosed in water-tight brass cases, which carry with them sufficient protection from mechanical injury.

Engine-shaft indicators are located in the pilot-house and central station and by direct mechanical attachment to the main engine-shaft permit the direction and number of revolutions of the engine to be read at any time. The dials of the indicators now made of brass are marked "Ahead" and "Astern." Between these indicators rests a pivoted arrow actuated by a double set of magnets. As these magnets are put into circuit by the transmitter they move the arrow intermittently either to the right or left, marking thus each revolution of the shaft. With a stop watch the revolutions per minute may be easily and quickly noted. The shaft-speed transmitter has re-

*It must be held in mind that these systems are available under all conditions. The writer adopts this classification merely for convenience.

*The adoption of steam turbines for propelling purposes now requires an entirely new design of instrument, due to the lack of close control of turbine speeds and increase in propeller revolutions. Therefore these instruments are designed to transmit any number of revolutions. The proposed type is similar to the familiar "carriage call" device.

*The dials of the steering telegraphs have recently been changed to read as follows: "Amid," "Course," "Steady," "Starboard," "Port," "Meet Her," "Ease Helm," "5 Degrees," "10 Degrees," "15 Degrees," "Standard," "Hard Over."

ceived very beneficial development in the past three years. From a device, which was not only very careless in its operation, but so overworked that its parts could not stand the continued strains, there emerges an instrument thoroughly reliable and not apt to lead to the engineer's increase of vocabulary. A worm-band is securely fastened to the main shaft, into which engages a worm-wheel. This latter by an extension shaft carries and operates the electrical contacts fixed on a drum. The worm-wheel revolves once for every ten revolutions of the main shaft, thereby lessening greatly all strains. The electrical contacts can be so arranged that they mark every revolution or any proportional number. The brushes, as in the other instruments, are of carbon.*

Tenacity of Crude Methods.

While great improvements are made in important large systems and apparatus, it is remarkable how long crude methods remain by which the desired results are attained. Contractors for battleships are required to demonstrate that the vessel will under certain stipulated conditions acquire and maintain a guaranteed speed. It can be plainly seen that the greatest requisite to meet this condition is sufficient and constant steam pressure. Passing from this stage the smooth and regular firing of the boilers becomes the point of vital interest for the accomplishment of the result, of interest not only to the builder but as well to the owner, for he also desires that the vessel be capable at all times of producing this guaranteed speed. Until recently the method employed was by word of mouth from the engine room with men calling off the time intervals from watches, these latter posted in each fire-room. Today these signals are automatically and chronologically regulated and transmitted from the engine room to each fire-room. The transmitter consists essentially of a small motor driving through gear and two steel discs a drum containing on its periphery contact segments. Between the steel discs is placed a raw-hide pinion movable from the circumference of the disc to the center. By varying the position of this pinion the revolutions of the contact drum are controlled. A graduated pointer on the exterior of the water-tight case permits the interval of firing from twenty seconds to ten minutes. This transmitter is connected by a cable of wires to the various indicators, one usually in each fire-room. These are designed to produce both aural and visual signals, *i. e.*, a large gong and incandescent lamp. They are about 14 in. in diameter, marked with raised letters "Fire Furnace No. —" above a small opening. In the interior a brass dial cut with the figures of the furnace numbers is revolved by a ratchet movement accomplished by magnets, as they are energized by the closing of the circuits controlled by the transmitter. In this way the number appears in the opening of the indicator simultaneously with the sounding of the gong. This is the simplest system that has found favor at the present time, although there are others which, being more complicated, still provide the same results.

*This instrument is now to be superseded by a direct reading instrument—designed to indicate continuously any and all speed changes.

The Call-Bell System.

Employed for use in the officers' quarters the call-bell system is one entirely of comfort and convenience. The various pantries and orderlies are supplied with annunciators connected with push-buttons located in the officers' state-rooms and offices. This system divides into groups corresponding to the military grouping or rank of the officers. There are calls for the admiral and captain, ward-room calls, junior officers' calls and warrant officers' calls. Since the general change in type of installation from molding to conduit, the design of all annunciators, push-buttons, and accompanying appliances take the prevailing characteristics of water tightness. The annunciator drops are carefully constructed on the gravity principle with sufficient safety to protect against false signals due to vibrations or gun shock. The call-bell system, which operates in conjunction with the voice-tube system, is sharply divided for military safety into exposed and unexposed calls. In such manner the circuits that may be required in the opening of an engagement, and thereby made useless when the conflict rises to its height, will not make unavailable those circuits which in the interior of the vessel are still of vital necessity. It is the practice to duplicate the call, that is, that a push-button and bell are required at both ends of the voice tube. As may be surmised, it often transpires that many voice tubes with their calling apparatus meet in one compartment. This leads to a system of stations located at important points throughout the vessel. At these stations it is convenient to group all the voice tube mouth pieces, push buttons, bells, or buzzers and annunciator on a brass panel. This preserves space and produces an excellent installation. The push buttons are all carefully labeled so that communication can be quickly and, with the aid of the annunciator, intelligibly established.

Voice Tube.

It may be written without fear of contradiction that voice tubes parallel every important system of interior communication. They are seamless hard drawn brass tubes varying in external diameter from 1½ to 4 in. Tubes vary in thickness for the purpose of mechanical strength, those which are led in straight runs No. 20 B. W. G. and those for bends and where subject to mechanical strains No. 14 B. W. G. Where tubes connect two terminal points by a direct path, or of a large diameter, so that they may be utilized for shouting tubes, or when they are employed for gun firing control, they are not provided with calling arrangements as above explained. Certain of these tubes are fitted with whistle mouth pieces in lieu of the bell and push button. Mouth pieces differ in design for nearly every condition of use, and only a detailed description could fairly represent and explain them. Indeed, as new conditions arise, or more efficient methods present themselves, the mouth pieces are immediately attacked and the old types ordered into exile. Between compartments that are water tight special mouth pieces of water tight design are installed; between non-water tight compartments, or non-water tight and water tight, a simple covered or open type. For shouting tubes, usually 3 in. or 4 in. in diameter, a design of the pattern of a megaphone is preferred. In the boiler rooms, where the forced draft occasions a disturbing pressure, the design provided is that of a diaphragm in the mouth piece, which can be only affected by the human voice. The tubes used solely for the control of gun fire are aranged so that a long flexible tube can be plugged into the permanent mouth piece. This flexible tube ends in a headgear containing in some conditions only two ear pieces and in others the addition of a mouth piece. This design permits the men at the guns to have the freedom of their hands, at the same time receiving direct aural orders from the officer in charge of the guns. It will be observed later how this system has taken its cue from the present adaptation of the telephone for this like duty. To obtain the greatest good from the voice tube system extreme care is observed in all requirements of its installation. Those points of inefficiency which were indicated in the description of this system for merchant vessels are overcome as far as

possible in naval vessels. The navigating bridge is in most recent designs entirely enclosed, and the voice tube connecting the engine room, irrespective of other considerations, is led in the most direct line to the engine starting platform. Machinery noises and vibrations are not, to be sure, entirely overcome, but every effort is exerted to accomplish the intelligent transmission of the voice. The criterion at the present moment must appear in the abundant and important uses that our navy finds for their increased employment.

(*To be continued.*)

ANNUAL CONVENTION OF AMERICAN BOILER MANUFACTURERS' ASSOCIATION.

The twenty-first annual convention of the Association was held in Detroit on Aug. 10, 11 and 12, the president, Col. E. D. Meier, in the chair. Among the subjects of a marine nature was the discussion of the steamboat inspection rule requiring all boiler heads on western river steamers to be 5/8 in. thick, instead of 1/2 in., as formerly allowed, led by Capt. Rees, of Pittsburg, who gave the rule hearty approval, saying that trouble with the old 1/2-in. heads was frequent, but not with the heavier heads now required. Col. Meier pointed out that these boilers are all externally fired and worked extremely hard under rates of combustion reaching 50 lb. per sq. ft. of grate.

Discussion of the best method of promoting circulation in corrugated furnace boilers while getting up steam was general, and the various methods employed, such as the steam jet in the bottom, the hydrokineter, the pump, the screw propeller, the internal feed pipe, etc., were taken up in detail.

H. J. Hartley, of Cramp Co., Philadelphia, compared the revised rules of the board of supervising inspectors of steam vessels of 1909 with previous rules and said that the new rules were a great improvement on the old. Capt. Rees said that this improvement was due entirely to the efforts of the committee of the association which dealt with the matter. Capt. Rees urged that the association go on record as demanding that plates should be stamped with the tensile strength actually found from the coupons tested by the government inspectors and not arbitrarily fixed at 62,000 lb., when it might considerably exceed that figure. In this he was supported by the president and resolution to that effect was passed.

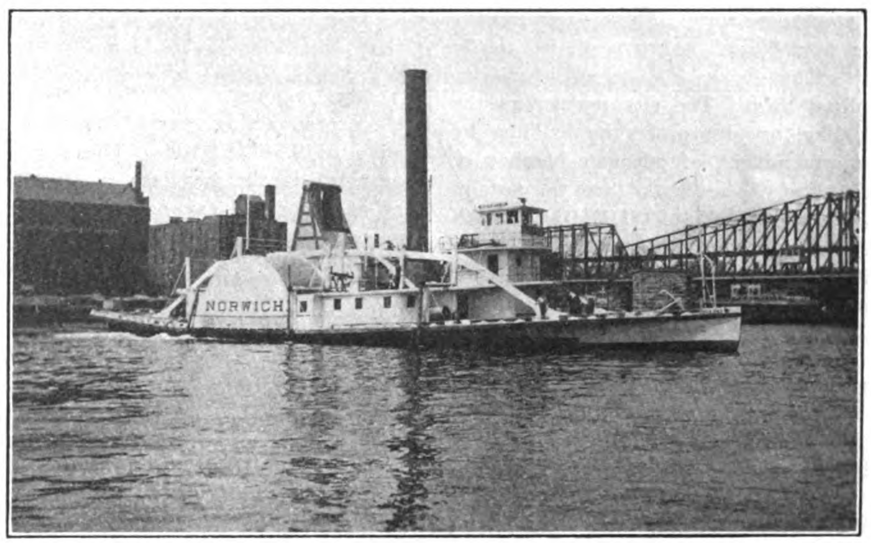
A resolution was also passed condemning the specifications for boiler plate recommended by the American Society for Testing Materials at its recent Atlantic City convention, because of the higher sulphur and phosphorus allowed under them and asserting that the revised specifications are formulated for the convenience of the steel makers, who had not lived up to the agreement made through the American Steel Plate Association with the Boiler Manufacturers' Association.

Col. E. D. Meier, New York, was re-elected president, and J. D. Farasey, Cleveland, secretary. The next convention will be held in Chicago and will occupy four days.

SIDE-WEEL STEAMER NORWICH.

Herewith is published a photograph of the veteran side-wheel steamer Norwich, which was built at New York in 1836, and which has been assigned to the second squadron in the naval parade of the Hudson-Fulton celebration at New York on Sept. 25, next. Unfortunately, fire broke out on this old steamer, Aug. 30, starting apparently in the lamp room on the lower deck. Before it could be extinguished the joiner work had been completely destroyed with the exception of the pilot house and a room underneath, and the wheel boxes. This is the second fire that has broken out on the old steamer in two years. She was practically destroyed by fire at Rondout in December, 1907, and was sunk to save her. She lay in the ice until opening of navigation in the spring and the management decided not to rebuild her. Mrs. S. G. Coykendall, a daughter of the late Major Cornell, of the Cornell Steamboat Co., owners of the Norwich, prevailed upon the management to restore the boat to its original condition for the Hudson-Fulton celebration. It is extremely unfortunate, therefore, that she should burn again at this time, but a large force of men have been put to work upon her and it is expected that she will be ready by Sept. 20.

The Norwich was originally built for the passenger trade on Long Island Sound. In the early 50's she was taken to the Hudson and put in trade at Rondout, with the steamer Emerald. Later she was converted into a tow boat, and has plied the Hudson ever since, serving as an ice crusher during the winter months.



THE NORWICH, SAID TO BE THE OLDEST STEAMER IN THE WORLD.

WESTERN DRY DOCK AND SHIP BUILDING CO.

The citizens of Port Arthur have ratified the agreement for the establishment of a ship yard at Port Arthur, made between the city council and the Western Dry Dock & Ship Building Co., which is a subsidiary of the American Ship Building Co.

By this agreement the company on its part contracts to build, equip and operate in the city, first a dry dock capable of receiving and handling the largest vessels plying on the great lakes, and, second, a ship building plant adequate for the constructing and equipping of such vessels. The building of these works to be begun within two months of the date of ratification by the ratepayers or of the date of the passing by the provincial legislature of an act empowering the municipality to enter into the agreement, should the authority of such an act be found to be necessary. Both dry dock and ship building plant are to be ready for operation on Sept. 1, 1911. At least 300 hands are to be kept in steady employment in the

works. A site of 100 acres, designated in the Strathcona property, which is owned by the city, is to be provided free of cost to the company, along with suitable water frontage on Thunder Bay.

All of the property of the company is to be exempt from taxation, except for school purposes, and the school taxes are fixed at $2,000 per annum for 20 years. For the first 10 years of the company's operations it is to receive from the city an annual cash subsidy of $25,000, but if fewer than 300 hands are kept at work in any year the subsidy shall be such ratio of the $25,000 as the number of hands actually engaged bears to 300. However, the company may in years subsequent to any in which its hands are not kept up to the specified number employ hands in excess of that number, and thus earn the portion of the subsidy it fell short of in a previous year. The subsidy is to be solely for the operation of the plants, and no part of it can be earned by the work of erecting and installing them. The city undertakes the building, or to procure the building by the government, of adequate breakwater protection. The works are to cost in the neighborhood of $1,000,000, though in the agreement no mention is made of the sum to be laid out on their account.

RECORD ORE SHIPMENT

The double holiday at the lower lake ports has caused considerable congestion of vessels, especially so as the upper lake docks worked both Sunday and Labor day. It will take at least a week to return to normal conditions on Lake Erie. Carriers are crowded badly at all ports and some extraordinary shifts are being made, as for instance sending a vessel from Cleveland to Buffalo to unload. Obviously this condition entails a serious loss of time. Many of the vessels will have to return light to the head of the lakes for, while coal is moving quite freely, it is not moving fast enough to supply this sudden increase in tonnage.

The ore movement during August established a record, exceeding 7,000,000 tons for the first time in the history of the business. In fact not until 1890 were 7,000,000 tons moved in any one year on the lakes. The exact figures for August are 7,193,199 tons. The fleet has moved 22,588,549 tons up to Sept. 1, which is only 1,753,003 tons less than the corresponding movement during 1907. It is clear that the 1907 record can easily be equaled and probably will be, as shippers appear to be anxious to move all the ore possible. Following are the ore figures tabulated to Sept. 1 for the past three years:

ORE SHIPMENTS.

Port.	Aug. 1909.	Aug. 1908.	Aug. 1907.
Escanaba	1,037,341	597,220	918,286
Marquette	542,607	279,610	574,659
Ashland	639,581	444,246	607,653
Superior	1,110,213	611,321	1,334,790
Duluth	2,279 242	1,764,053	2,051,280
Two Harbors	1,584,215	1,053,205	1,320,143
Total	7,193 199	4,749,655	6,806,811

1909 increase, 2,443,544 tons, or 51.45%.

	To Sept. 1, 1909.	To Sept. 1, 1908.	To Sept. 1, 1907.
Escanaba	3,053 845	1,351,513	3,731,165
Marquette	1,413,568	625,399	1,924,464
Ashland	1,700 769	1,037,185	2,314,769
Superior	3,686,323	1,723 208	4,416 454
Duluth	7,713,377	4,583,987	7,202,645
Two Harbors	5,020,667	2 663,644	4 752,064
Total	22 588,549	11.984,936	24,341,552

1909 increase, 10,603,613 tons, or 88.48%.

SAULT STE. MARIE CANAL COMMERCE.

During August 8,988,223 net tons of freight were moved through the canals at Sault Ste. Marie, making a total movement to Sept. 1 of 29,812,256 tons against 20,271,904 tons for the correspondiing period last year, a gain of 9,540,352 tons The August movement is the heaviest in the history of the canal, exceeding the previous record, made in June, 1907, by 122,781 tons. Following is the summary:

EAST BOUND.

	To Sept. 1, 1908.	To Sept. 1, 1909.
Copper, net tons	51,839	65,499
Grain, other than wheat, bushels	12,918,066	13,831,382
Building stone, net tons.	1,019	1,125
Flour, barrels	2 164,814	2,969,368
Iron ore, net tons	11,767,874	21,320,149
Pig iron, net tons	12,700	17,549
Lumber, M. ft. B. M.	261,839	315,129
Wheat, bushels	31,365,572	24,497,194
Unclassified freight, tons	50,810	89,654
Passengers, number	20,322	22,755

WEST BOUND.

	To Sept. 1, 1908.	To Sept. 1, 1909.
Coal, hard, net tons	901,335	798,545
Coal, soft, net tons	4,995,541	4,802,158
Flour, barrels	685	1,805
Grain, bushels	700	1,000
Manufact'd iron, net tons	143,575	272,979
Iron ore, net tons		8,213
Salt, barrels	339,056	444,404
Unclassified freight tons	402,336	522,188
Passengers, number	21,729	24,652

SUMMARY OF TOTAL MOVEMENT.

	To Sept. 1, 1908.	To Sept. 1, 1909.
East bound, tons	13,778,509	23,341,909
West bound, tons	6,493,395	6,470,347
	20,271,904	29,812,256

CONTRACTS FOR LAKE VESSELS.

Lake ship builders will enjoy a very prosperous winter season. James C. Wallace, president of the American Ship Building Co., closed a contract last week for four bulk freighters. The names of the contracting parties are at present withheld, but they are all for independent interests. The vessels are of the 9,000-ton class. Antonio C. Pessano, president of the Great Lakes Engineering Works of Detroit, closed a contract with Harry Coulby, president of the Pittsburg Steamship Co., for three freighters to be duplicates of the Thomas F. Cole, that is to say, 600 ft. over all, 580 ft. keel, 58 ft. beam and 32 ft., deep. The Lake Erie Excursion Co. gave an order to the American Ship Building Co. for a duplicate of the Americana, to operate between Buffalo and Crystal Beach. This makes a total of 16 vessels that lake ship builders have closed for 1910 delivery—nine by the American Ship Building Co. and seven by the Great Lakes Engineering Works. The Great Lakes Engineering Works closed a contract two weeks ago with the Northern Lakes Steamship Co., a new Cleveland corporation, for three bulk freighters, and also has on hand an order for a package freighter.

OBITUARY.

Frank Stead Manton died suddenly at his summer home in North Wakefield, N. H., on Aug. 19. Mr. Manton devoted practically his entire business life to the affairs of the American Ship Windlass Co., having been connected with it for more than 50 years. He became the manager of the company when it moved its plant to its present location. Prior to that time the windlass business was carried on by the Hyde Iron Works, of Providence. Mr. Manton remained the active head of the American Ship Windlass Co. until December, 1906, when he disposed of most of his holdings and retired to private life, remaining, however, as one of the board of directors. It was Mr. Manton who conceived the idea of working a windlass and capstan by steam, and the first machines made by the company were practically presented to the original users. The steam towing machine, though not invented by him, was commercially developed by him and his engineers.

Mr. Manton was of a kindly and generous nature and was extremely fond of his friends, whom he always loved to have about him. His charities were numerous but quiet. He was a life member of the Society of Naval Architects and Marine Engineers, and was prominent in every movement having to do with the upbuilding of the American merchant marine. He is survived by a widow and daughter.

Contract for the construction of the Pearl Harbor dry dock with the San Francisco Bridge Co. for $1,760,000 has been approved by the secretary of the navy.

LUCKHURST COMBINED REAMER AND COUNTERSINK.

The Scully Steel & Iron Co., Chicago, are the agents for the Luckhurst combined reamer and countersink. A goodly number of ship builders and boiler makers speak highly of it. They obtain fair work as cheaply as before and save a great deal of friction during the construction of the work. The advantages of the tool are set forth as follows:

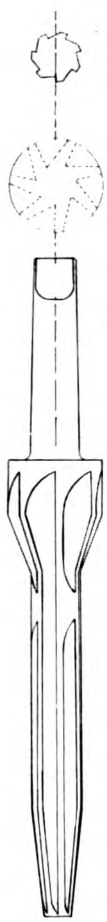


Fig. 76.

1. By one operation the tool reams out eccentric rivet holes in the two or three thicknesses of plating.

2. Because the tools are combined it insures not only the reaming but the recountersinking of the countersink, which in reaming is more or less destroyed and which is so often responsible for faulty rivets, as by the use of single reamers, recountersinking is frequently neglected.

3. The tools in alignment are connected by a smooth neck, about an inch to 1½ in. long, slightly smaller than the reamer to allow clearance of cuttings and prevent binding.

4. The advantage of the neck, besides connecting the tools, is that it holds the countersink up to its work of cutting the side of the countersink, which requires recountersinking, thus insuring a perfect head to the rivet. The single countersink tool naturally follows the shape of the hole and cuts eccentric holes, which is responsible for bad work.

5. When the combined tools are in general use, they speedily repay the user. Not only saving much inspection of holes before riveting but insuring efficient work and sound rivets when work is completed. It is well known that when slack rivets are cut out of shell plating of ships, that it is generally due to want of reaming but more frequently due to the countersink having been destroyed in reaming.

Fig. 76 gives a sketch of the tool.

FIG. 78.

Fig. 77 shows Capt. Allen Luckhurst arranging his combined reamer and countersink for exhibit.

Fig. 78 shows another exhibit where the captain has for company Tom Mason, superintendent of construction of the New York Ship Building Co., and some other familiar faces from the great lakes.

Fig. 79 shows a cut of the No. 40 Cleavland reversible drill. This tool will drill, ream or tap 2½ in. in steel. This reversible drill size 40 weighs 55 lb. with a length top to end of socket of 15 in. Length of feed, 3¾ in., and 4⅜ in. from side to center of spindle. The diameter and stroke of piston are 2 3-16 x 2⅝ in., with 200 revolutions

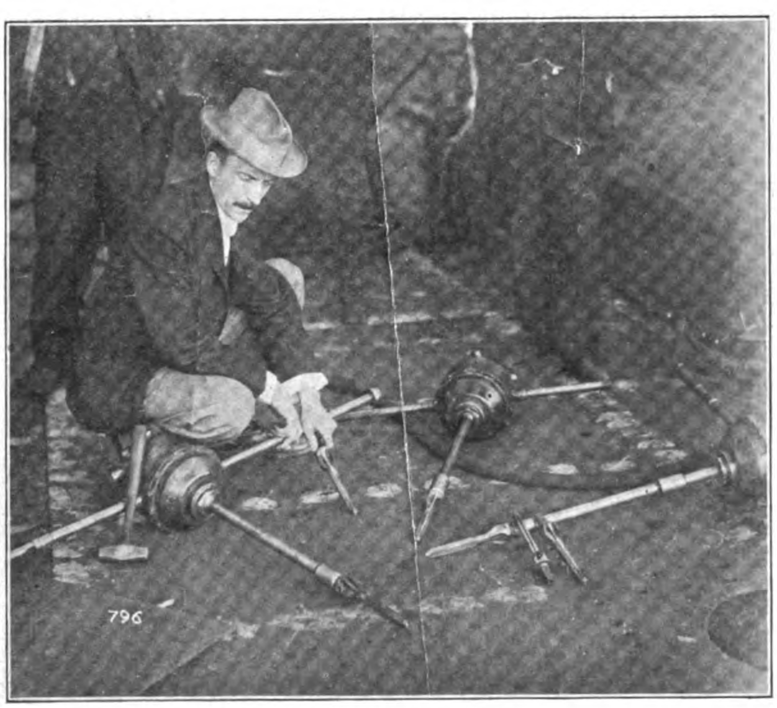


FIG. 77.

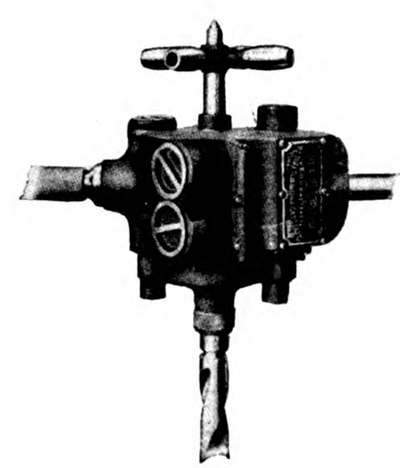


FIG. 79.

on 80 lb. pressure and 35 cu. ft. of free air.

Fig. 80 shows plan of drift pin, a very useful but much abused tool. This tool is a tapered steel pin and is very helpful in assembling of the plates and

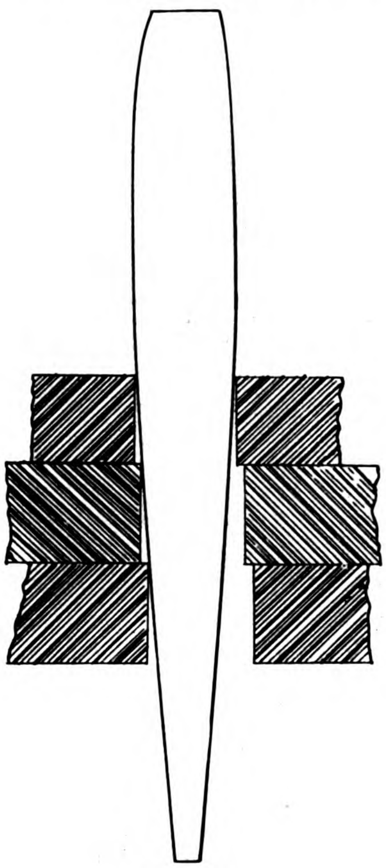


Fig. 80.

shapes, which is well known to the ship builder.

Sometimes the drift pin is used in fairing the holes, but it leaves a burr on the plate and makes it impossible to close up the material. The drift pin was very detrimental to iron, for when it was forced into the hole it cracked and burst the material at the

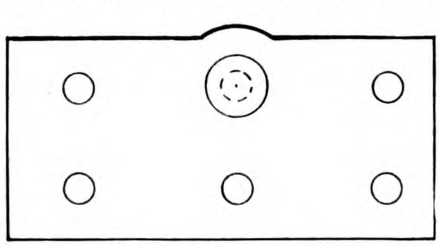


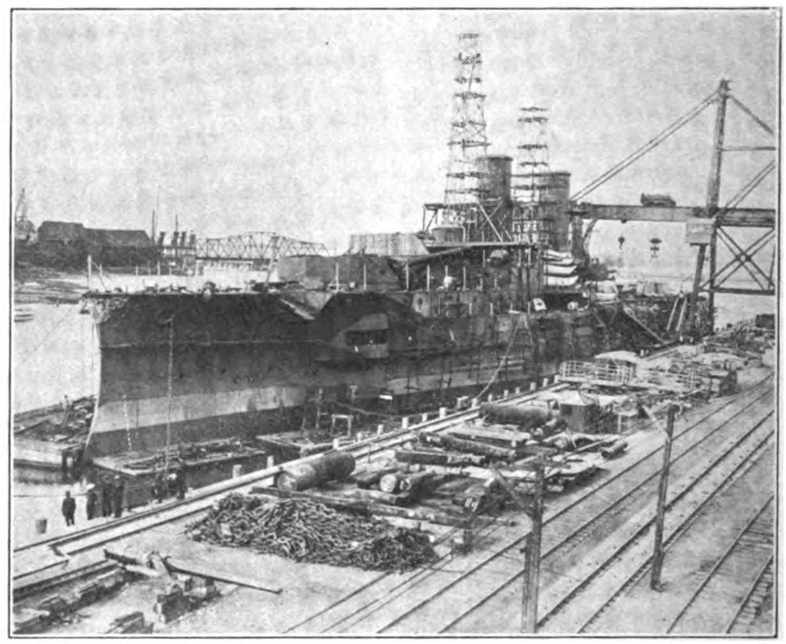
Fig. 81.

rivet hole. Good steel is not injured by drifting, for tests have shown that a steel plate can stand the enlarging of the hole to twice its diameter without showing any signs of fracture, as shown in Fig. 81.

As stated elsewhere in this issue by Robert Curr, in his excellent series of articles on "Lake Ship Yard Methods of Steel Ship Construction," "the mold system of work creates a greater percentage of unfair holes than the old style of lifting the plates from the ship, which of course increases the cost of reaming. The extra cost in reaming is a small matter compared to the advantages obtained by the mold system and a tool like a combined reamer and countersink must be a great saving in time at the same cost as compared with the changing of tools to do countersinking."

BATTLESHIP NORTH DAKOTA.

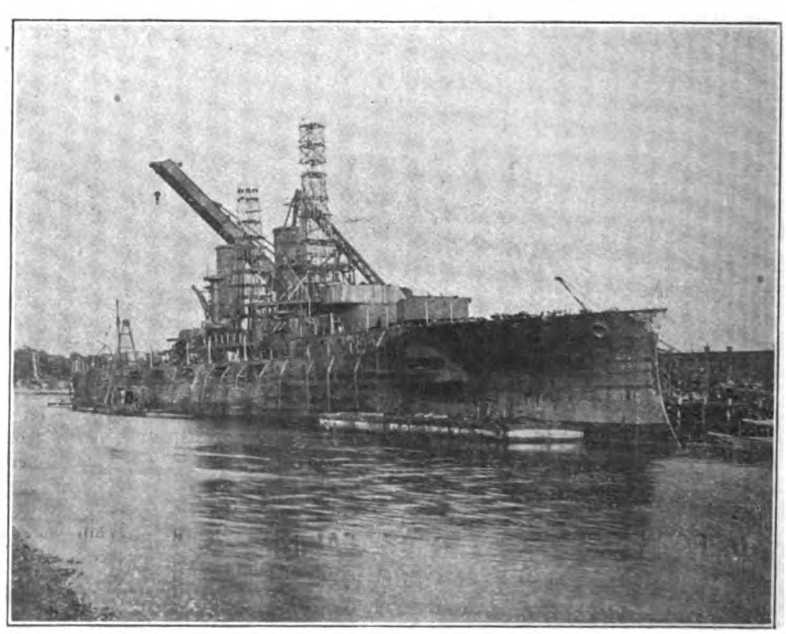
Herewith are published two photographs of the battleship North Dakota, taken on Aug. 1, at which time the vessel was 90.3 per cent completed. The Fore River Co. announces that the casement armor for which it has been waiting since last November, has at last passed test and will be delivered during September. The company is preparing to hold the official trial of the battleship in October.



BATTLESHIP NORTH DAKOTA ON AUG. 1. SHOWING HER 90.3 PER CENT COMPLETED.

SOCIETY FOR TESTING MATERIALS.

It should have been stated that the standard specifications for open hearth boiler plate and rivet steel, and for structural steel for ships published in the August issue of THE MARINE REVIEW, were taken from the proceedings of the Society for Testing Materials.



BATTLESHIP NORTH DAKOTA ON AUG. 1, SHOWING HER 90.3 PER CENT COMPLETED.

SHIP BUILDING DURING AUGUST.

The bureau of navigation reports 84 sail and steam vessels of 17,361 gross tons were built in the United States and officially numbered during August, 1909, as follows:

	WOOD.				STEEL.				TOTAL.	
	Sail.		Steam.		Sail.		Steam.			
	No.	Gross.	No.	Gross.	No.	Gross.	No.	Gross.	No.	Gross.
Atlantic and Gulf	7	1,008	20	594	1	1,034	2	5,650	30	8,286
Porto Rico	2	10	..	.....	..	.....	..	.....	2	10
Pacific	1	19	19	1,206	1	32	..	.....	21	1,257
Hawaii	..	.....	..	.....	..	.....	..	.....	..	.....
Great Lakes	..	.....	10	206	..	.....	4	6,907	14	7,113
Western Rivers	..	.....	17	695	..	.....	..	.....	17	695
Total	10	1,037	66	2,701	2	1,066	6	12,557	84	17,361

REPAIRS TO STEAMSHIP EIR.

The repairs to the Norwegian steamship Eir, which are being made by the Heffernan Engine Works, Seattle, are the most extensive that have been made to any vessel on the Pacific coast for over a year.

The Eir is a steel steamer 346 ft. in length, 49 ft. 5 in. beam and 29.35 ft. in depth, with a gross tonnage of 3,804. She went aground recently on the Grays Harbor bar and received severe injuries to her bottom.

She was docked at 2:45 p. m. Saturday, Aug. 14, in the Heffernan Dry Dock Co.'s floating dock at Seattle. This dock had been towed to Seattle from Quartermaster harbor, 30 miles away, only two days previously. That the dock was safely installed in its new location and ready to take on a 4,000-ton ship in two days time speaks well for the energy and resourcefulness of the Heffernan Dry Dock Co.

The work of repairing the Eir is being done by the Commercial Boiler Works, Seattle. The work consists in practically renewing the bottom of the vessel, particularly on the starboard side which received the most damage. Ninety shell plates have been taken out and faired in the shop; a number of plates were renewed. Some plates are being faired in place. The plates of the Eir are unusually large, those on the bottom being 26 ft. 6 in. in length and 6 ft. in width. Each of these plates weighs 3,800 lb. Their mere removal and replacement is considerable of a task. The plates are dropped onto rollers and hauled out of the dock into open space by means of blocks and tackle.

One hundred and five frames are being taken out and either faired in the shop or replaced with new material.

In riveting the plates in place again, pneumatic hammers are being used on the inside, it being impractical from a financial standpoint to use pneumatic riveters on the outside.

The work on the Eir involves an outlay of approximately $78,000. The contract calls for the work to be completed in 47 working days.

AKERS GEAR ON CAR FERRY ASHTABULA.

The Akers Steering Gear Co., 1160 Old Colony building, Chicago, has received an order from the Pennsylvania & Ontario Navigation Co., operating the car ferry Ashtabula, to equip that steamer with its emergency steam steerer. When the Ashtabula was built she was equipped with the Akers hand emergency gear, which has been used on several occasions during the past three years. During the present summer, however, the car ferry backed into a dock, striking the rudder and practically putting the regular steering engine out of commission. As the engine was built in Bath it was necessary to get the various parts from the manufacturers. Meanwhile the Akers hand gear was used with excellent results. As the car ferry has to be out in all sorts of weather, both fall and winter, the management concluded that it was not a sensible thing to steer her in emergency cases by hand and accordingly has ordered the hand gear taken out and the steam gear put in.

AUGUST LAKE LEVELS.

The United States lake survey reports the stages of the great lakes for the month of August, 1909, as follows:

Lakes.	Feet above tide-water, New York
Superior	602.42
Michigan Huron	581.04
Erie	572.79
Ontario	246.82

Since last month Lake Superior has risen 3 in., Lakes Michigan-Huron have fallen 1 in., Lake Erie has fallen 3 in., and Lake Ontario 4 in.

During September Lake Superior is likely to rise 1¼ in., Lakes Michigan-Huron are likely to fall 2 in., Lake Erie is likely to fall 3¼ in., and Lake Ontario 5 in.

Lake Superior is 7½ in. lower than the average August stage of the past 10 years and 6 in. lower than last year. It is 6½ in. higher than in July, 1892, but 11¼ in. lower than in 1899, and 10 in. lower than in 1903.

Lakes Michigan-Huron show a stage 1¾ in. lower than the average August stage of the past 10 years, and 8 in. lower than last year, but 14 in. higher than in August, 1896. In August, 1885, the water was 27¾ in. higher.

Lake Erie is 1½ in. above the mean August stage of the past 10 years, and 4¼ in. lower than in August last year, but 17 in. higher than in 1895. It is 15¾ in. lower than in August, 1876, and 15¾ in. lower than in August, 1883.

Lake Ontario is 4½ in. higher than the average August stage of the past 10 years, and 13½ in. lower than in August last year. In 1870, it was 13¾ in. higher, and in 1883 12¼ in. higher than in 1909. In August, 1895, it was 29¾ in. lower than this year.

UMBRIA AND ETRURIA TO BE SOLD.

The Cunard Steamship Co. have decided to sell their steamers Umbria and Etruria, which are at present laid up at Birkenhead. These vessels were built and engined by the famous firm of John Elder & Co. (now the Fairfield Shipbuilding & Engineering Co.), and the Umbria first sailed on Oct. 31, 1884, and the Etruria on April 25, 1885. They are each 500 ft. long and of 8,120 tons gross, with compound engines of 14,000 I. H. P., giving a speed of 19 knots, these engines being probably the largest compounds ever built, as soon afterwards twin-screws and triple-expansion engines were introduced. The vessels were, with the exception of the Oregon (also built at the Fairfield yard), the first to bring the voyage to the States under seven days. In 1882 the Alaska had reduced the time from Queenstown to New York to 7 days 6 hours 43 minutes; in 1884 the Oregon reduced it to 6 days 9 hours 42 minutes, and then the Etruria and Umbria held the blue riband till the end of 1889, when the City of Paris did the passage under the six days. These vessels have run successfully for a quarter of a century, and have been great favorites with Atlantic travelers, being splendid sea boats, and crossing with the same regularity as when they were first built.

PERSONAL.

J. H. Sheadle, of the Cleveland Cliffs Iron Co., who has been abroad during the past two months, returned this week.

WELIN DAVITS.

The Welin Davit & Lane & DeGroot Co., 17 Battery place, New York, has recently received orders for the complete equipment with Welin quadrant davits of the United States coast and geodetic survey steamers Bache and Patterson. William Cramp & Sons, Philadelphia, have ordered these davits for the steamships Ancon and Christobal, of the Panama Railroad & Steamship Co.'s line, as well as for three harbor tugs building for the quartermaster's department of the United States government. The Newport News Ship Building & Dry Dock Co., Newport News, Va., has ordered Welin davits for the steamships Bear and Beaver, which it is building for the San Francisco & Portland Steamship Co., of San Francisco, and also for the steamer Wilhelmina, which is under construction for the Matson Navigation Co., San Francisco. The Associated Oil Co.'s steamer, J. A. Chanslor, will also be fitted with these davits. The Standard Oil Co.'s steamer Imperial and the Erie railroad tug Daniel Willard, recently received equipments from the Welin Davit & Lane & DeGroot Co. direct.

NEW CUNARD LINER.

The Cunard line has given an order to the firm of Swan, Hunter & Wigham Richardson, builders of the Mauretania, for a large passenger steamer designed to take the place of the Lusitania and Mauretania when either of them are laid off. She will, however, be a smaller steamer than either of these, being about 20,000 tons, but her equipment will be of the finest character.

SHIP YARD NOTES.

The two vessels building at Newport News for the San Francisco & Portland Co. will be named Bear and Beaver.

The Portland Ship Building Co., Portland, Me., is to repair the lighthouse tender Geranium, the work comprising repairs to her paddle wheels and engines.

The three steamers building by the Maryland Steel Co., Sparrows' Point, Md., for the American-Hawaiian Steamship Co., will be named the Kentuckian, Georgian and Carolinian.

The Erie Basin Dry Dock Co., Brooklyn, N. Y., has obtained a contract for lengthening the Merchants & Miners Transportation Co.'s steamer Howard 40 ft., as well as to install a new set of steel boilers.

William E. Woodall & Co., Baltimore, Md., have launched a seven-pocket mud scow, having a capacity for 800 yards. She was built for stock and is of the following dimensions: Length, 25 ft.; beam, 38 ft.; depth, 14 ft.

The Skinner Ship Building & Dry Dock Co., Baltimore, Md., is building a large tug boat for the Baltimore & Ohio railway, to be 118 ft. 6 in. long, 24 ft. beam and 16 ft. 6 in. molded depth. She will have fore and aft compound engines with cylinders 20 and 40 in. diameters by stroke of 28 in., supplied with steam by a Scotch boiler.

The Clinton Ship Building & Repair Co., Philadelphia, Pa., recently launched the new steel steamer Clio, which has been built for service between Philadelphia, Odessa and other points on Delaware Bay. She is owned by S. B. Watkins, of Odessa, and others. The Clio is 116 ft. long, 23 ft. beam and 7½ ft. depth of hold.

The Manhattan Navigation Co. are asking for bids for two additional steamboats for the Hudson river trade. These boats are to be fitted with a number of special and unique features for accommodation of passengers, and it is the intention to have them superior to anything now in existence. Boats are to be of medium size, and to cost not over $400,000 each.

Bids will soon be called for for reconstructing the government dredge Chinook, the sum of $125,000 having been set aside by the last congress for this purpose. As soon as the Chinook is ready for service she is to be put at work on the bar at the mouth of the Columbia river, Oregon. The appropriation provides that $80,000 may be spent upon the repairs to her boilers and $45,000 upon the repairs to her hull.

M. P. Howlett, of Philadelphia, has placed a contract with a ship building firm at Wilmington, Del., for the construction of a wooden tug 75 ft. long, 18 ft. beam and 9 ft. depth of hold, to be named after her owner.

The lighthouse tender Mayflower has been ordered to the yard of the Bath Iron Works, Bath, Me., to receive repairs and alterations to her hull and engine to cost $25,754. The Mayflower was built at the Bath Iron Works in 1897.

The battleship South Carolina recently underwent a successful trial trip off the Delaware capes, in which it was demonstrated that the vessel is the fastest ship of its class in the navy. In the four-hour full speed run the South Carolina made 18.88 knots, the contract requirement being only 18.5 knots. In the five high-speed runs over the measured mile the battleship attained a mean speed of 19.25 knots. During this standardization run the South Carolina's fastest mile was 20.52 knots.

A record three knots faster than that of any ship in the United States navy was scored Sept. 1 by the Bath-built torpedo boat destroyer Flusser in a standardization trial, the first of her official acceptance trials on the Rockland mile course. Her fastest mile was made at the rate of 33.7 knots an hour, while another was at the rate of 33.4 knots. The average of her five top speed runs was 32.7 knots. The contract speed requirement is 28 knots.

The Maryland Steel Co., of Sparrow's Point, Md., is completing work on the plans for the steamer which it is to build for the Baltimore, Chesapeake & Atlantic Railroad Co. and they are to be submitted to the officials of the steamboat company for approval soon. The new steamboat is to be 190 ft. over all, 36 ft. beam of hull and 56 ft. over guards. She will be of light draught, about 6 ft., to permit of the vessel reaching any of the landings in the territory in which the railroad operates its vessels. It is expected that the steamer will be completed and ready to go into commission by Jan. 1. She will be used as a night boat on the Rappahannock, Potomac and Patuxent rivers.

The Heffernan Dry Dock Co., Seattle, has transferred its 8,000-ton floating dry dock from Quartermaster harbor, near Tacoma, to a new site purchased on the East Waterway, Seattle. While in some respects the location at Quartermaster harbor was ideal, it was too far from the center of activities in Seattle to be convenient, for which reason the dock was moved. The Heffernan Dry Dock Co. has been recently awarded the contract for the repair of the steamship Eir. The price approximates $78,000 and the dry dock company is under contract to have the Eir ready in 47 working days. This is one of the largest repair jobs awarded by the underwriters on the Pacific coast in more than a year.

The William G. Abbott Ship Building Co., of Philadelphia, has been awarded a contract by Philadelphia interests for the construction of a barge 190 ft. long, 23 ft. beam and 7 ft. depth of hold, to be built of Delaware oak and Virginia pine. She will be the largest barge ever constructed on the lower Delaware.

The T. S. Marvel Ship Building Co., Newburg, N. Y., was recently awarded a contract for the construction of a ferryboat for the Newburg & Fishkill Ferry Co. The new boat will be 160 ft. long and 56 ft. beam and is to be completed by May 1, 1910. She will be a twin screw propeller with a steel hull and is to be equipped with two Scotch boilers.

M. P. Smith & Sons Co., 116 Broad street, New York, have recently awarded a contract to the Staten Island Ship Building Co., of Port Richmond, S. I., N. Y., for the construction of a steel steamer for use in their wrecking and transportation business. The new vessel will have all modern appliances for the work in which she is to engage. Her engines will be of the fore and aft compound type with cylinders 18 and 38 in. diameter by 26 in. stroke. There will be two Scotch marine boilers carrying 160 lb. of steam. The engines are expected to develop from 750 to 800 H. P. Plans and specifications for the vessel were drawn by Theodore Ferris, of Cary, Smith & Ferris, naval architects, of New York. The contract calls for the delivery of the vessel on March 1, 1910.

NEW LAKE CHARTS.

The United States Lake Survey office during June published two new charts pertaining to its series of navigator's charts of the great lakes. These charts are engravings lithographed in several colors to depict land areas, shallow and deep water, sailing courses, lights and other aids to navigation, are prepared from government surveys, and, by congressional direction, are sold at a nominal figure covering cost of paper and presswork.

Coast chart No. 3, Lake Huron, covers the south end of that lake from Harbor Beach on the west shore and Port Albert on the east (Canadian) shore to the head of St. Clair river. It embodies all Canadian and United States government surveys available to date. The scale of the chart is 1:120,000 (1 inch = about 1.9 miles), and a special inset on the chart shows the harbor at Goderich, Ont., on scale of 1:10,000 (6⅓ in. to the mile).

Chart of the Apostle Islands, Lake Superior, shows, on one sheet, the entire Apostle group and Chequamegon Bay, as well as the shore line of the lake from Little Girl Point, Mich., to Sand Point, Wis. It includes the results of the detailed resurvey of the island region made by the Lake Survey in 1901-1902, and other antecedent and subsequent government surveys. The chart scale is 1:60,000 (1 in. = 5,000 ft.). These charts may be had from THE MARINE REVIEW.

The Keuffel & Esser Co., of Hoboken, N. J., have just issued a little circular on blue print papers. Prices and weights are given.

The C. O. Bartlett & Snow Co., Cleveland, O., has recently closed contracts for complete coal mine equipments for the McGillveary Coal & Coke Co. of Coleman, Alberta, and the West Canadian Collieries at Bellevue, Alberta. The contracts were closed through F. C. Greene, mining engineer, and will include a steel tipple with all the necessary machinery, including the Greene Patent Transfer Dump, type 4, for each plant, as well as a complete power plant equipment and haulage system for both plants. The plants will be entirely electrically operated and are to be in operation by Nov. 1, 1909.

PROPOSALS.—Sale of U. S. S. Enterprise and U. S. Navy Coal Barges Nos. 7, 8 and 42.—Sealed proposals will be recd. at the navy department until noon on Oct. 1, at which time and place they will be opened, for the purchase of the U. S. S. Enterprise, appraised value $7,000; U. S. Navy Coal Barge No. 7, appraised value $1,000, U. S. Navy Coal Barge No. 8, appraised value $1,000; and U. S. Navy Coal Barge No. 42, appraised value $400. They will be sold for cash to the person or persons or the corporation or corporations offering the highest price therefor above the appraised value thereof. A separate proposal for each vessel bid upon must be submitted in a sealed envelope addressed to the Secretary of the Navy, Washington, D. C., endorsed "Proposals for the Purchase of the U. S. S. ——;" (naming the vessel for which offer is made) and each proposal must be accompanied by a satisfactory certified check for not less than 10 per cent of the amount of the offer. On application to the Navy Department forms of bids and bonds, together with the terms and conditions of the sale, also a printed list giving general information concerned the vessel, will be furnished. The vessel can be examined at any time after Sept. 1, by applying to the commandants of the navy yards where they lie—Enterprise, Navy Yard, Boston, Mass.; Coal Barge No. 7, Naval Station, Key West, Fla.; Coal Barge No. 8, Naval Station, Key West, Fla.; Coal Barge No. 42, Navy Yard, Mare Island, Cal. They must be removed from the limits of the respective navy yards within such reasonable time as may be fixed by the department. The department reserves the right to withdraw any or all vessels from sale and to reject any or all bids. Wm. S. Cowles, Acting Secretary of the Navy. 8-24-09.

CONSTRUCTION AND DELIVERY OF steel barges, U. S. Engineer Office, Vicksburg, Miss., August 16, 1909. Sealed proposals for constructing and delivering steel barges will be received here until noon, Oct. 6, 1909, and then publicly opened. Information on application. Clarke S. Smith, Capt., Engineers.